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Faculty of Electronics, Communications and Automation
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Home Automation – A Challenge for Electrical Designers, Contractors and Electricians

This Master's Thesis has been submitted for an official examination for the degree of Master of Science in Engineering

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Tiivistelmäteksti:

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Avainsanat: kotiautomaatio, rakennusautomaatio, sähköurakoitsija, sähkösuunnittelija, sähköasentaja, sähköurakka.

HELSINKI UNIVERSITY OF TECHNOLOGY Abstract of the Master's Thesis

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Abstract:

Home automation is defined as single or networked devices and systems that add to the safety and coziness of homes, maintain pleasant indoor conditions energy efficiently, facilitate inhabitant's residency and coping of everyday chores and enable content transfer connections within home's internal and external networks.

In Finland there are several competing home automation systems in the market but none of them has gained competitive advantage over others. The technologies are available but there are no standard practices between designers, contractors and installers to realize the systems. Home automation has not been studied from the point of view of electrical designers and contractors before.

The aim of this thesis was to study the challenges of home automation in electrical design, contracting and installations in Finland. The study was conducted by interviewing electrical engineers, contractors and home automation device manufacturers.

This thesis revealed that the home automation professionals knew many challenges concerning their field. As the result of the thesis information about the current practices of Finnish electrical designers and contractors were researched and the challenges of the home automation field were accumulated. The thesis presents future recommendations to improve the challenges and the home automation professionals' business models.

Keywords: home automation, building automation, electrical contractor, electrical designer, electrician, electrical contract.

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Espoo 25.6.2009 Satu Marttila

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ABBREVIATIONS AND ACRONYMS

CAD	Computer Aided Design
CCTV	Closed Circuit Television (Video Monitoring)
CO_2	Carbon Dioxide
DALI	Digital Addressable Lighting Interface
EIB	European Installation Bus
HVAC	Heating, Ventilating and Air-Conditioning
I/O	Input/Output
ISM	Industrial, Scientific and Medical radio frequencies
IHC	Intelligent House Control
IR	InfraRed
KNX	Konnex, open standard for home and building control
LON	Local Operating Network, standard for building control
PLC	Power Line Communications
RF	Radio Frequency
STUL	the Electrical Contractors' Association of Finland
TP	Twisted Pair wires
WLAN	Wireless Local Area Network
WPAN	Wireless Personal Area Network

KEY CONCEPTS

Ad hoc Network A network where connections are established when needed and only as long as needed without relying on fixed infrastructure (Broch, et al., 1998).

Architectural Floor Plan A diagram drawn in scale of the relationships between rooms, spaces and other physical features at one level of a house. Floor plans will also include details of fixtures, such as sinks, stoves, refrigerators and fireplaces.

Bill of Quantities / Quantity Calculation A document used in tendering in the construction industry in which materials, parts, and labor (and their costs) are itemized. Quantity calculation is used to determine the contract tender price.

Building Automation A system that provides comfortable indoor conditions by controlling heating, ventilation and air controlling (HVAC) equipment and systems of a building (Kastner, et al., 2005).

Building Services HVAC systems, lighting systems, power distribution, waste management, domestic hot water, transportation, communication and information networks, safety systems and security systems (Kastner, et al., 2005).

Device Manufacturer The companies that are producing and marketing automation system equipment and devices. In this thesis the term contains both manufacturers and wholesalers of the products.

Domotica/Domotics (Domus = house) Information technology in the home, digital home.

Electrical Constructor A person who is responsible for the installation of electrical systems according to the regulations and the electrical documents of a house.

Electrical Designer A person who is responsible for creating the electrical documentations of a house according to the regulations. Electrical designer's education is offered in universities of applied sciences (Electrical Engineer).

Electrician / Electrical Installer A person who has skills and education to install, repair and maintain electrical systems and devices. Electricians' education is offered in trade schools and colleges. Only installers with Safety Technology Authority (TUKES) can install electrical systems (TUKES, 2007).

Electrical Wiring Plan A drawing where the electrical wires and symbols are superimposed on to the architectural floor plan (Traister, et al., 2003).

Field Bus A communication channel including data protocols, physical and electrical interfaces, and communication media that connects devices and systems, and is usually controlled by an automation system or device (Pakanen, et al., 2006).

Home Automation An automation system of a resident house that improves the safety and coziness of the house, maintains pleasant indoor conditions energy efficiently, facilitate inhabitants' residency and coping of everyday chores and enables content transfer connections within home's internal and external networks (Pakanen, et al., 2006).

Incandescent lamp Commercialized in 1879 by Thomas Edison, incandescent lamp has a threadlike conductor surrounded by inert gas or vacuum that heats to incandescence when electric current is passing through it (European Commission Energy, 2008).

Interoperability The ability of two or more systems or components to exchange information and to use the information that has been exchanged (Institute of Electrical and Electronics Engineers, 1990).

Principal designer The party responsible for the overall planning of the building or other construction project (TUKES, 2007).

Usability Engineering Lifecycle Model for user centered design process. Consists of 11 stages: Know the user, Competitive analysis, Setting usability goals, Parallel design, Participatory design, Coordinated design of the total interface, Apply guidelines and heuristic analysis, Prototyping, Empirical testing, Iterative design and Collect feedback from the field use (Nielsen, 1993).

1 INTRODUCTION

Building automation systems are commonplace in office, commercial and industrial constructions. Airports, commercial centers, hospitals and factories are all built with automated controlling systems to create the best possible indoor conditions. Yet, homes where people spend most of their time, are built nearly without any automation. Still the automation systems could improve health, energy-conservation and comfort.

In Finland there are several competing home automation systems in the market but none of them has gained competitive advantage over others. Technologies are available but there are no standard practices among designers, contractors and installers to realize the systems. Lack of regulation of electrical design has lowered the quality of electrical documentation and electrical contractors often receive inadequate designs based on which they are expected to realize the home automation systems. The electrical designers are not responsible over their documentation leaving the contractors liable for the realization of the system.

Home automation has not been actively studied from the point of view of electrical designers and contractors before. The past research has concentrated mostly on the end users, especially on the elderly and disabled users who benefit from automation the most. It is important to study the actual process of developing the home automation systems so that the operations can be improved and updated where needed. Electrical industry is very conservative and thus the changes within the field are slow. However, small changes in procedures can make significant improvements in the workflow and accuracy of the product.

1.1 OBJECTIVE OF THE THESIS

The aim of this thesis is to discuss the challenges of home automation and to search the reasons why home automation is not widespread in Finland. Another objective is to research the current work practices and business models of electrical contractors and designers and how they could be improved. Third objective is to define how the Finnish electrical designers and electrical contractors could act as home automation integrators who design, install, maintain and support the home automation products and systems.

1.2 RESEARCH QUESTIONS

The objectives of this thesis are summarized in the following six research questions:

1. How should the home automation systems be included in the building contract?

2. What are the **challenges** the electrical designers, contractors and device manufacturers face concerning the home automation systems?

3. What are the current **business models of home automation** associated services/products and how could they be improved?

4. Is there any need to improve the **device manufacturers' business model**?

5. Can the electrical contractors, designers or electricians act as **integrators** of home automation systems?

6. Is there a possible **killer application** and would such product improve the home automation situation?

1.3 STRUCTURE OF THE THESIS

The content of this thesis is divided in nine chapters. Literature study is presented in chapters two and three and the research methods with applicable theory in chapter four. Empirical study is introduced in chapter five. The results are in chapter six and the analysis of results in chapter seven. Discussion of the empirical study is presented in chapter eight. Conclusions are summarized in chapter nine.

1.4 RESTRICTIONS

This study focuses on home automation systems in Finland through the perspective of Finnish electrical designers and contractors. Interviews were restricted mostly to the southern Finland, with one reply coming from central Finland and one questionnaire reply coming from western Finland. The interviews were targeted towards electrical designers and contractors who work directly with end clients. This restricted also the size of the companies, as mostly small companies with 1-5 electricians work in private constructions. The focus of this study is in the current situation in the home automation field and the possible future improvements.

1.5 AUTHOR'S CONTRIBUTION

The author has worked as an electrical designer trainee for telecommunication systems during past two years and has participated in projects concerning telecommunication network, fire alarm, burglar alarm, video surveillance and access control designing for industrial buildings.

2 BUILDING PROJECT LIFECYCLE

This chapter presents a lifecycle model of building construction projects. The chapter explains the two main project delivery types that are also used in home automation system contracting.

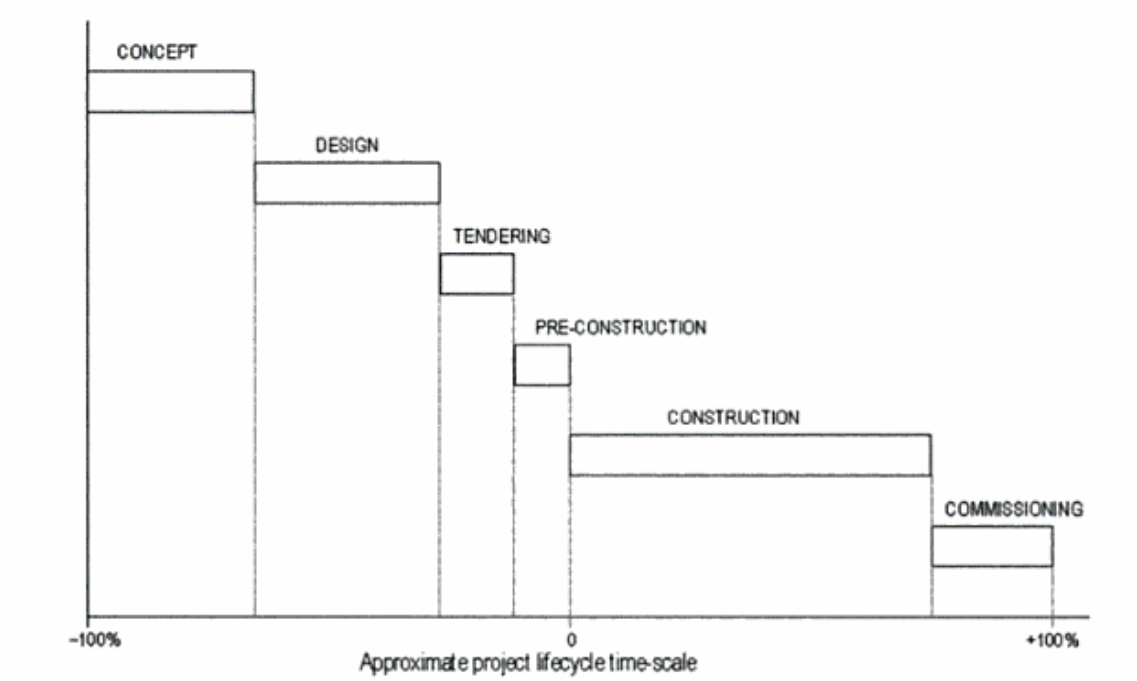

Figure 1. Building project lifecycle (Uher, et al., 2002).

Building projects pass through a number of sequential stages known as project lifecycle. Figure 1 presents the project lifecycle stages, defined as concept, design, tendering, pre-construction, construction and commissioning. Effective management of each stage is vital for project success.

The conceptual stage defines the extent of the work of the project and its end product. In the design stage the concept of the project is translated into the physical design of the project. The design documentation will form the basis of tender documentation. Building contractors will rely on the tender documents when they calculate their tender price. After the contractor has been selected the tender documentation becomes contract documentation, which will be relied on by the contractor as the accurate and reliable documentation of the project. Pre-construction stage of the project lifecycle starts after the tender has been approved and it is the time for the contractor to organize the construction work. The project is then realized in the construction stage, which the contractor is responsible for. The final phase of commissioning starts from the project completion date and expires after the end of the defects liability period (Uher, et al., 2002).

The traditional building project is called design-bid-build (D-B-B), where the house owner contracts separate professionals for each of the design and construction of the building. There are three separate phases in the D-B-B project: design phase, bidding or tender phase and construction phase. For electrical project (with or without home automation) the phases are electrical design, tender and electrical contract phase. In the electrical design phase the owner hires an electrical engineer to design the electrical wiring plans and other electrical documentation for the project. The tenders may be open, where any contractor can bid, or the tenders can be requested from pre-selected contractors. The engineer should review the bids, discuss with the owner about the suitability of the offers and give advice to the owner on ranking the bids. In the construction phase the design documentation is then realized by the contractor whose bid was accepted. The benefit of the D-B-B delivery is the independency of the designer to work in the best interest of the client. If the design documentation is complete, there is an equal chance for different contractors to send tenders and the client will get a range of choices for contractors. The disadvantage is that the design documentation has to be complete before tenders are requested, as redesign in the construction phase is expensive. Another disadvantage is that the contractors will try to find the most economical way to do the work by using the lowest quality products that the contract will permit and often change the products to alternative cheaper ones to make profit. The D-B-B is considered one of the most expensive forms of construction project delivery type for the client.

Another construction project delivery type is design-build (D-B), where the design and construction professionals are hired with a single contract. There are two versions of the D-B project, the co-operation of the designer and the contractor or the contractor working as the dominant partner by sub-contracting or himself providing the designs. The D-B project type allows one to overlap the design and construction phases, speeding up the delivery schedule and reducing the client's risk. The benefit of this type of project is that it gives the designer an opportunity to be involved during construction and enhances communication between the service provider and the client when the project is delivered by a single company. On the other hand the delivery price can be difficult to estimate for the entire building project before the design documentation is complete. Another disadvantage is that the dominant contractor may overrule the designer's recommendations of quality in the interest of cost (Schexnayder, et al., 2003).

The lifecycle model and the project delivery types apply to any building project, but in this thesis the focus is on automation constructing which is part of the building electrical contract.

3 AUTOMATION

This chapter contains a literary study on Building and Home automation.

3.1 BUILDING AUTOMATION

A building automation system (BAS) provides comfortable indoor conditions by controlling heating, ventilation and air controlling (HVAC) equipment and systems as well as other electrical systems. The electrical systems of a building are referred to as building services. The building services are traditionally managed as separate systems but using BAS will optimize the control and the interoperability of the systems.

The building services can be divided into HVAC, lighting systems, power distribution, waste management, domestic hot water, transportation, communication and information networks, safety systems and security systems. Safety systems include fire alarm, gas alarm, water leak detection, emergency sound system, emergency lighting and closed circuit TV (CCTV). Security systems are divided into intrusion alarm, access control, CCTV (video monitoring) and audio surveillance.

The goal of BAS is to increase functionality of the building, reduce management costs and improve energy efficiency. The benefits are significant especially in large and complex buildings when the building systems are integrated by BAS. Successful integration requires wider expertise than traditional installations and professionals of the various systems are required to cooperate within the building project.

An example of building automation system is presented in Figure 2. In the figure, the system is divided into three levels: management level, automation level and field level. Field level connects the HVAC devices, collects and transmits measurements from the devices and controls the operation of the HVAC devices in response to the commands received from the BAS. Automation level processes the data prepared by field level and establishes logical connections and control loops. The automation level prepares the results for the highest level, the management level. The management level has access to the information within the entire BAS. Alerts are created in exceptional situations and historical data can be accessed to create reports and statistics. Modification of parameters is available through a user interface (Kastner, et al., 2005).

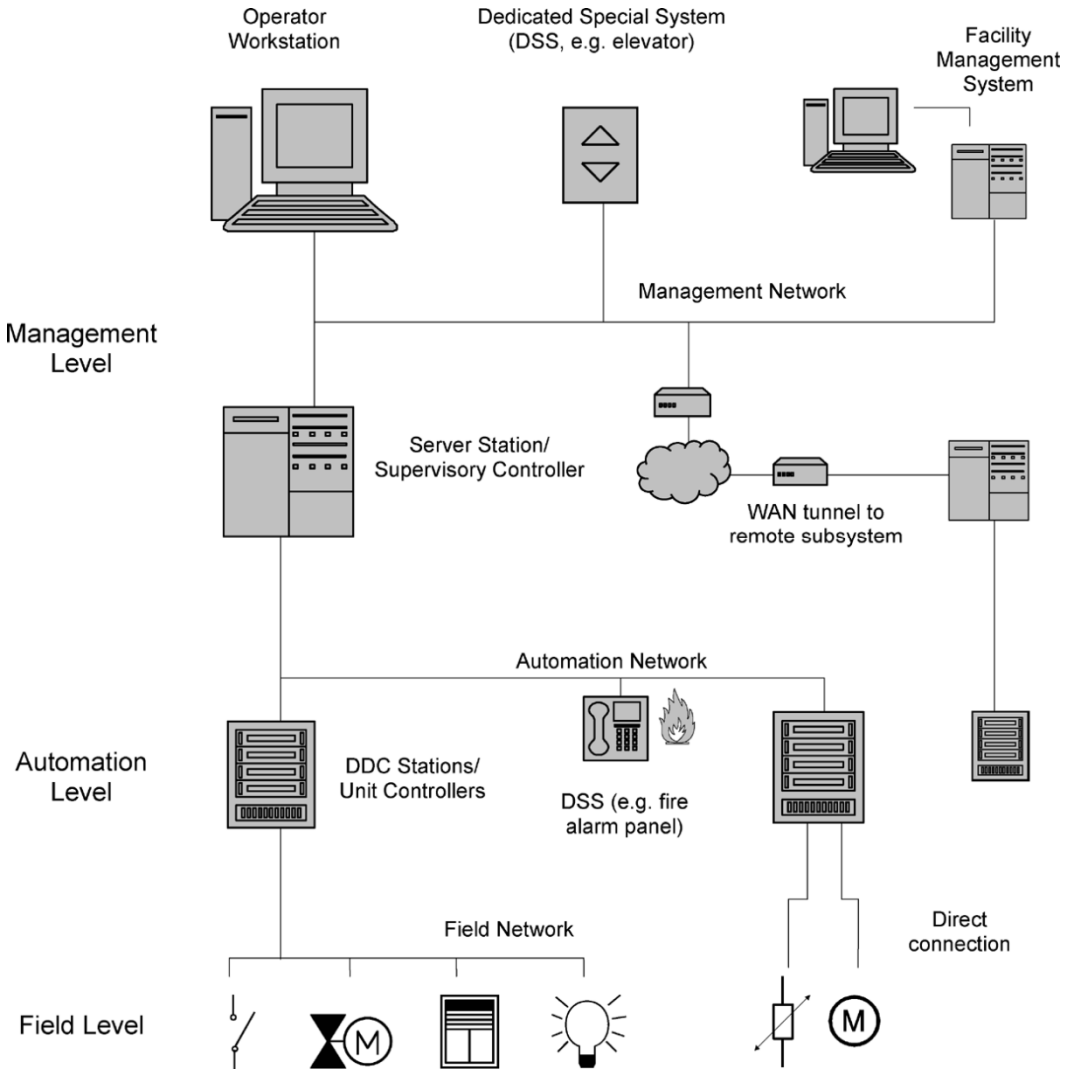

Figure 2. Building automation, three-level functional hierarchy (Kastner, et al., 2005).

3.2 HOME AUTOMATION

Home automation is defined as single or networked devices and systems that add to the safety and coziness of homes, maintain pleasant indoor conditions energy efficiently, facilitate inhabitant's residency and coping of everyday chores and enable content transfer connections within home's internal and external networks (Pakanen, et al., 2006).

The difference between home and building automations is that the home automation systems are smaller in size and operation. Users of home automation are generally not knowledgeable of the technologies and devices that establish the home automation systems. Another difference is that home automation systems are mainly focused on improving the living comfort of the residents whereas building automation is focused on maximizing companies' economical benefit and productivity of the employees and minimizing the maintenance costs of the buildings.

The use of automation in homes has been slowly growing in number according to Finnish device manufacturer Ensto's electrification survey for homebuilders and repairers. According to the survey that was conducted through rakentaja.fi website, 13 percent of detached homebuilders have chosen to use a home automation system in 2008 (Ensto, 2009a).

3.3 HOME AUTOMATION LEVELS

Home automation systems have evolved from the traditional electrical systems during the past decades. The systems' level of automatization has improved from single stand-alone devices to full-house systems where nearly every electrical system can be controlled by the automation system.

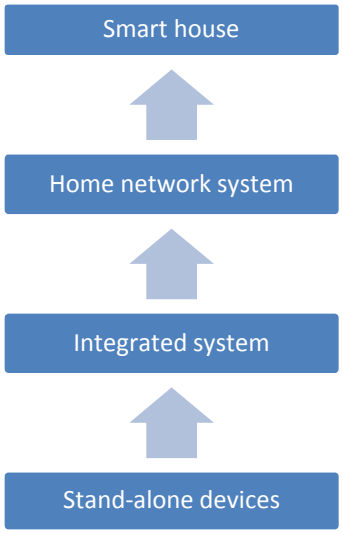

Figure 3. Home automation system evolution (Pakanen, et al., 2006).

In the lowest level home automation can mean stand-alone devices with integrated sensors and actuators, designed for specific automation applications. An example is a room thermostat or an automatic timer controlling light.

In the second level the stand-alone devices can be integrated with an automation system but the simplest automation systems are built with only a small number of relay controls for stand-alone devices. For example air conditioner with built-in automated controls can be considered as integrated automation. Also simple relay-controlled home automation systems are integrated systems and they offer most notably mobile control of heating system that is especially useful for holiday residences.

On the third level are home automation systems based on a home network that integrates different electronic systems and creates an Internet connection for the systems, including automation, security and entertainment systems. Schematic diagram of such system is

presented in Figure 4. The central equipment of the home network system is a home (Internet) gateway that connects the slower home automation field bus to the faster home network and links the system to the Internet. Through the Internet gateway the house owner can connect to third-party service providers for services, such as house maintenance or security services.

"Smart Home" or "Smart House" is a term that represents the highest level of automation in buildings, where practically all of the building's electrical systems are digitalized and controlled by the automation system. The system uses artificial intelligence to learn the user's living patterns to customize the system features to fit the user's needs without manual adjustment of the devices. This type of realization has not gained popularity and the current home automation systems are mostly either integrated systems or bus based systems that may include home network for entertainment purposes.

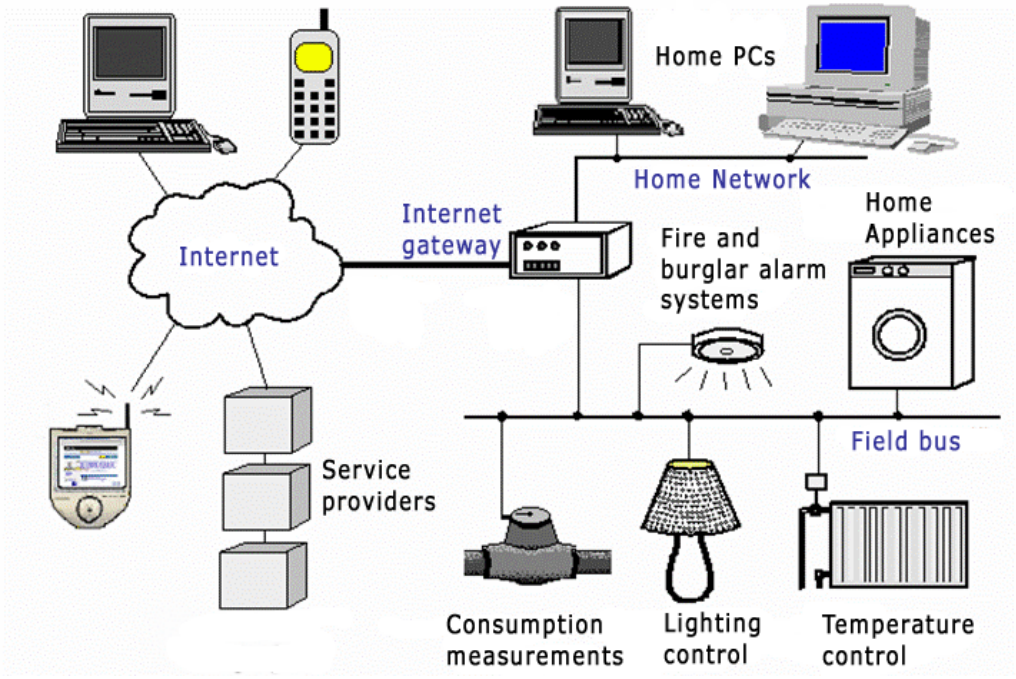

Figure 4. Home network based home automation system principle diagram, modified from (Pakanen, et al., 2006).

3.4 HOME AUTOMATION TOPOLOGIES

The home automation systems can be realized with several different network topologies. The topology is important as it determines the cabling style the house must be equipped with in order for the system to function. The most common topology is a star topology or a centralized system, where the intelligence is in the central main unit and the controlled

devices have no intelligence and are cabled separately to the central unit. Somewhat improved version is the hierarchical topology where the main unit is at top and each device has a hierarchical order. Bus based systems have a common data transmission channel and each device has its own intelligence and is connected together with the bus forming a decentralized system. Mesh or peer-to-peer topology is used in transmitting RF signals. (Sähkötieto, 1998 pp. 50-51). See Figure 5 for a graphical representation of the different topologies.

The automation systems may have several network topologies incorporated to the system, especially if the system includes both wired and wireless components.

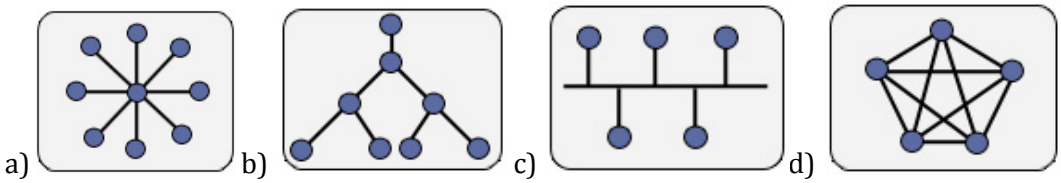

Figure 5. Network topologies: a) Star topology, b) Hierarchical topology c) Bus topology and d) Mesh topology (peer-to-peer networks) (Learn networking, 2008).

3.5 HOME AUTOMATION TRANSMISSION CHANNELS

The physical transmission channels for electrical systems can be divided into wired and wireless connections. Wired transmission channels include structured wiring (twisted pair), power line, phone line, coaxial cable and optical cable. Wireless channels are divided into radio frequency and infrared connections. For home automation systems the most common transmission channels are structured wiring, power line and radio frequencies.

Structured wiring or twisted pair wiring (TP) is the most common type of transmission channels used for home automation systems. Twisted pair has two insulated conductors that are symmetrically twisted around their common axis. The twisting reduces disturbance currents and electrical magnetic fields.

Power line communications (PLC) use the traditional electrical network and its a major advantage is that it offers an easy connection for all house appliances without extra cost. The biggest drawback is the need to remove electrical network noise and reflections.

Wireless radio frequency (RF) signals offer installations without cables for home automation systems. The RF signals are less reliable than wired connections and the signal must be encrypted to ensure security of the system. The RF signals attenuate quickly and can only pass through one or two walls in a house. There are only limited amount of free

radio frequencies and the RF system may transmit or receive disturbances from other networks (Sähkötieto, 2008).

3.6 HOME AUTOMATION STANDARDS

There are many competing standards in the home automation field, such as ZigBee, Z-Wave, Insteon, Bluetooth, Wibree, LonWorks, HomePlug, EIB/KNX, X10, RS-485 and Modbus to name a few. The vast majority of home automation systems are proprietary systems that have not been standardized, making it difficult to choose a suitable system to use. Standardized systems are often safer to implement, as there is a better chance of getting replacement components in the future if something breaks in the system. Usually there are many different companies that produce equipment for a standardized system, whereas proprietary systems have to depend on single or limited number of manufacturers. Still some proprietary systems have gained widespread and long lasting influence in home automation system market and thus the standardization should not be considered a deal breaker when choosing a home automation system.

Table 1 presents a comparison between some of the competing field bus standards: DALI, which is mainly used for lighting control; KNX and LON which are used in building and home automation; and an American de facto standard X10 which is an example of a small scale home automation system that is widely popular in the United States.

Table 1. Home and building automation field bus standard comparison.

Name	Standard	Transmission media	Speed	Automation type
DALI	IEC 60929	Twisted pair cables Infrared	1200bps	Building automation (lighting control)
KNX	ISO/IEC 14543-3 CENELEC EN 50090 CEN EN 13321-1 ANSI/ASHRAE 135	Twisted pair cables Power line Radio frequencies Infrared Ethernet	9,6 Kbps 2,4 Kbps	Building automation Home automation
LON	ANSI/EIA-709 EN14908 IEEE 1493-L ISO/IEC 14908	Twisted pair cables Fibre Power line Radio frequencies	1,25 Mbps 10 Kbps	Building automation Industrial automation Home automation
X10	de facto	Power line Radio frequencies Infrared	100 bps	Home automation

Konnex, or KNX for short, is a European standard that is promoted by Konnex Association, founded in 1999 by the members of the European Installation Bus Association (EIBA),

BatiBUS Club International (BCI) and the European Home System Association (EHSA). KNX, previously known as EIB, was developed to become the single standard for field bus applications in buildings (KNX Association, 2007).

KNX system is specified for several data transfer media: twisted pair cables, power line transmission, radio frequency, infrared and Ethernet. The KNX standard comprises actually several separate standards for transmission medias, protocols, electrical and physical connection types, different uses of the bus and interoperability properties (Pakanen, et al., 2006). Not all of the KNX functions are standardized and some properties are proprietary and must be purchased by a licensing fee, such as the programming tool, ETS Professional –program (Ensto, 2009c).

X10 power line control protocol was developed in 1975 in the USA by Pico Electronics in order to allow remote control of home devices and appliances. The system uses existing electrical wiring to transfer the control commands and has a transmission speed of 50-60bps. The system can be controlled with dedicated remote controllers (IR/RF) or via PC and it can be programmed by free software called "ActiveHome". The advantage of this system is that it is affordable, there is no extra wiring needed and the products are easily programmed and used and they can be installed in plug-and-play fashion. The X10 home automation system can be built gradually from a single solution into a full house system. Up to 256 appliances can be controlled to either turn on/off or dim/brighten (only incandescent lights) (Technica Pacifica, 2005). Although X10 is the most widespread automation system in the USA, it has not been as successful in Europe although it does have retailers in Europe as well.

When compared to wired systems, **wireless** automation systems offer greater flexibility in building installation. There are many competing wireless standards in the market with varying features in frequency, transmission speed, range of transmission and type of application that they fit for. Table 2 presents a comparison of RF standards aimed for home automation and home networking field. Home and building automation uses slower transfer rates in the field (device) level than the computer and home networking applications.

Radio frequency (RF) systems mainly use the license-free Industrial, Scientific and Medical (ISM) bandwidths of 868MHz and 2.4GHz. Most RF systems use battery power, but there is at least one batteryless implementation: EnOcean, a Siemens spin-off company formed in 2001 that uses only mechanical energy necessary to press a switch or move a door handle (Martin, 2007). The process is called energy harvesting and it is possible through

piezoelectric ability of certain materials to create energy through mechanical stress. Other possible energy harvesting sources are electrodynamics, photovoltaics and thermoelectrics.

Table 2. Radio frequency standard comparison.

Name	Standard	Frequency	Speed	Automation type
Bluetooth	IEEE 802.15.1	2.4 GHz	1 Mbps	computer networking
EnOcean	proprietary	868 MHz	125 Kbps	home automation building automation
INSTEON	proprietary	902-924 MHz	13 Kbps	subsystem in building automation
Wi-Fi	IEEE 802.11b	2.4 GHz	11 Mbps	computer networking
WLAN	IEEE 802.11	2.4/5 GHz	11-54 Mbps	computer networking
ZigBee	IEEE 802.15.4 protocol is proprietary	868 MHz / 2.4 GHz	20-250 Kbps	Small scale building automation home automation
Z-Wave	proprietary	868 MHz / 2.4 GHz	9.6 / 40 Kbps	Small scale home automation, max. 232 devices / network
KNX RF	IEC 870-5-2 EN 13757-4:2005	868 MHz	16.4 Kbps	building automation home automation

3.7 ECOLOGICAL ASPECTS CONCERNING HOME AUTOMATION

Building industry, construction and building heating and electricity consume 40% of energy supplies and produce 30% of the CO_2 emissions in Finland (Mikkola, et al., 2002). To improve building energy consumption, several ecological developments have initiated recently, including phasing out the least effective lamps by EU regulation and introducing energy certificates for buildings. Even though home automation systems have not yet been taken into consideration with the energy certificates, the systems can monitor energy consumption and increase energy efficiency.

EU approved an Eco Design directive on March 18th, 2009 to phase-out the least efficient incandescent lamps in favor of halogen lamps, fluorescent lamps and LED-lights. The directive will ban the selling of 100w clear glass lamps starting September 2009, which progressively leads to replacement of all incandescent light bulbs by improved alternatives until 2012 (EUR-Lex, 2009).

Lighting may represent up to fifth of a household's electricity consumption, according to European Commission's Technical Briefing of Household Lamps (European Commission

Energy, 2008). Lighting control is the most visible element of a home automation system and using dimming and switching unnecessary lights automatically off with the system is a direct way to save energy.

In January 2008 a law of energy certificates of houses was passed in Finland for new constructions, and for the old houses the certification started in January 2009. For buildings with less than six apartments the certificate is voluntary if the building was constructed before 2008, but the certificate is obligatory for all new buildings (Suomen Ympäristökeskus, 2008).

In 2002 Bremen University of Applied Sciences started a four-year study of KNX controlling versus the traditional electrical installations by equipping part of their new informatics building with KNX network and metering system. The use of an automation system was found to significantly reduce energy costs in the study compared to the traditional electrical installations (Figure 6 and Figure 7). Especially the lighting control had instant effect in the energy consumption (Figure 8).

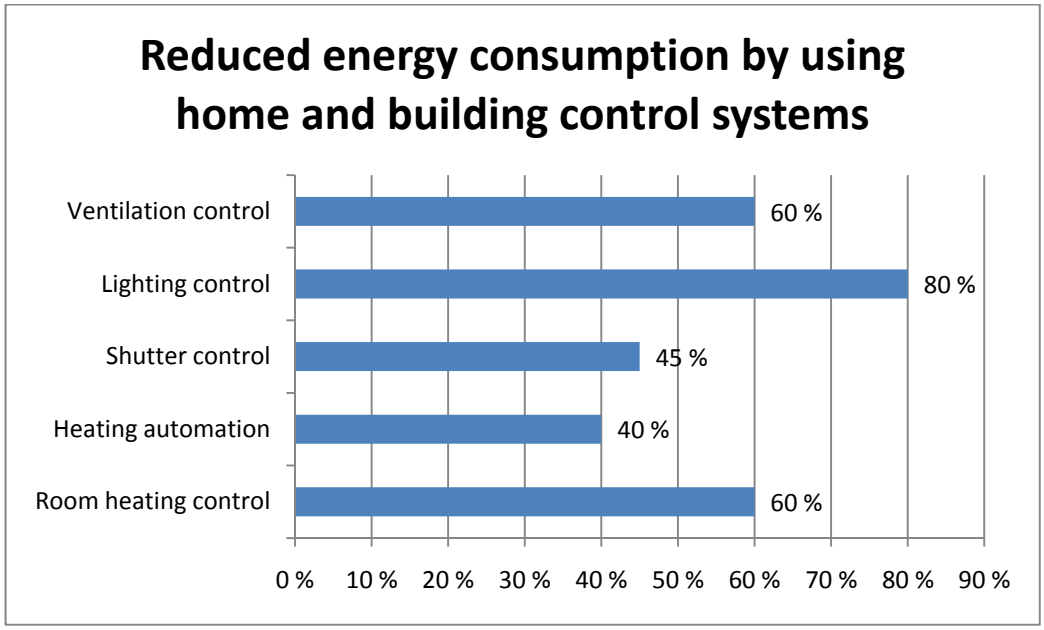

Figure 6. Reduced energy consumption by using home and building control systems, modified from (KNX Association, 2009).

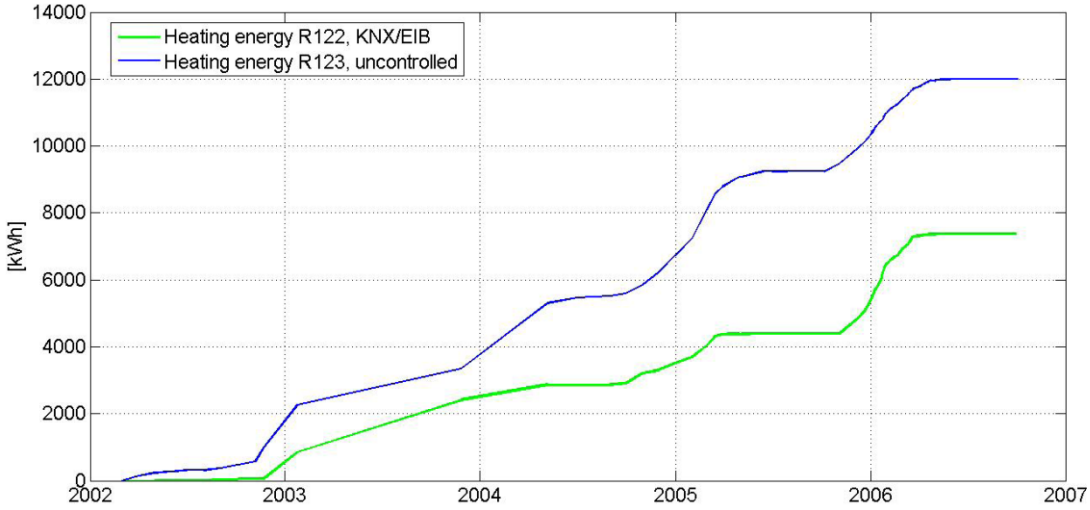

Figure 7. Heating energy savings with KNX compared to traditional thermostats, a Bremen University study (Mevenkamp, 2006).

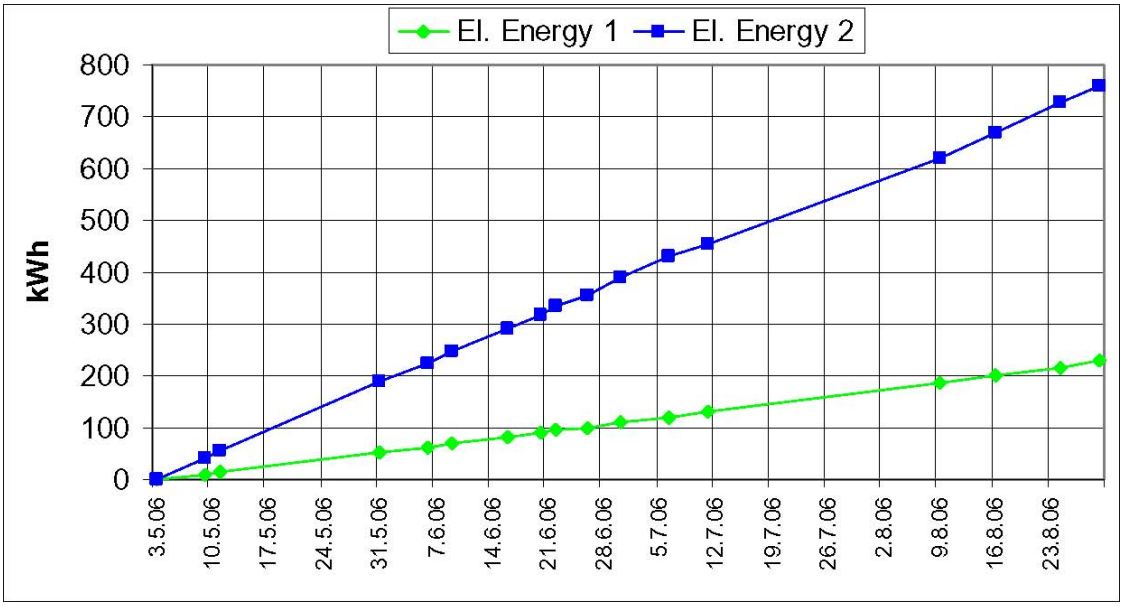

Figure 8. Energy consumption of KNX controlled (el. energy 1) and uncontrolled (el. energy 2) lamps during 4 month period (Mevenkamp, et al., 2006).

However, a two-year field test of Bremer Energie-Consens and the Bremen Energy Institute conducted in three resident apartment buildings equipped with wireless centralized room temperature controls showed no decrease of energy consumption compared to three similar houses with traditional electrical systems. It was noticed that the residents were already saving heating energy as much as possible before the experiment, the wireless automation system was too complex to use and many of the residents still manually controlled the thermostats instead of letting the system function properly. The conclusions of the study suggested that the user behavior was a major

influencing factor towards the successful reduction of energy consumption, and that there will be need to design the systems in such a way that the users' technical competence is taken into account.

3.8 COMMERCIAL HOME AUTOMATION PRODUCTS

This chapter presents some of the home automation products in the Finnish market and their basic functions.

There are several different types of home automation systems in the Finnish market and their precise categorization is difficult due to the differences in the realization of the systems. In this study the systems are presented in two groups: integrated systems, such as Ensto's ECO-600 and Ouman's EH-60, and bus-based or home network level systems such as KNX and Elko's Living System (previously sold as Strömfors IHC).

The major device manufacturers in the Finnish home automation field are Ensto, Schneider Electric Finland, Elko and Berker. There are also many single system providers that sell controlling devices that can also control home automation, such as Ouman. Figure 9 represents the price-feature chart of home automation systems that are aimed for resident house market. The figure is approximate but gives an impression on the alternative systems' price and feature range.

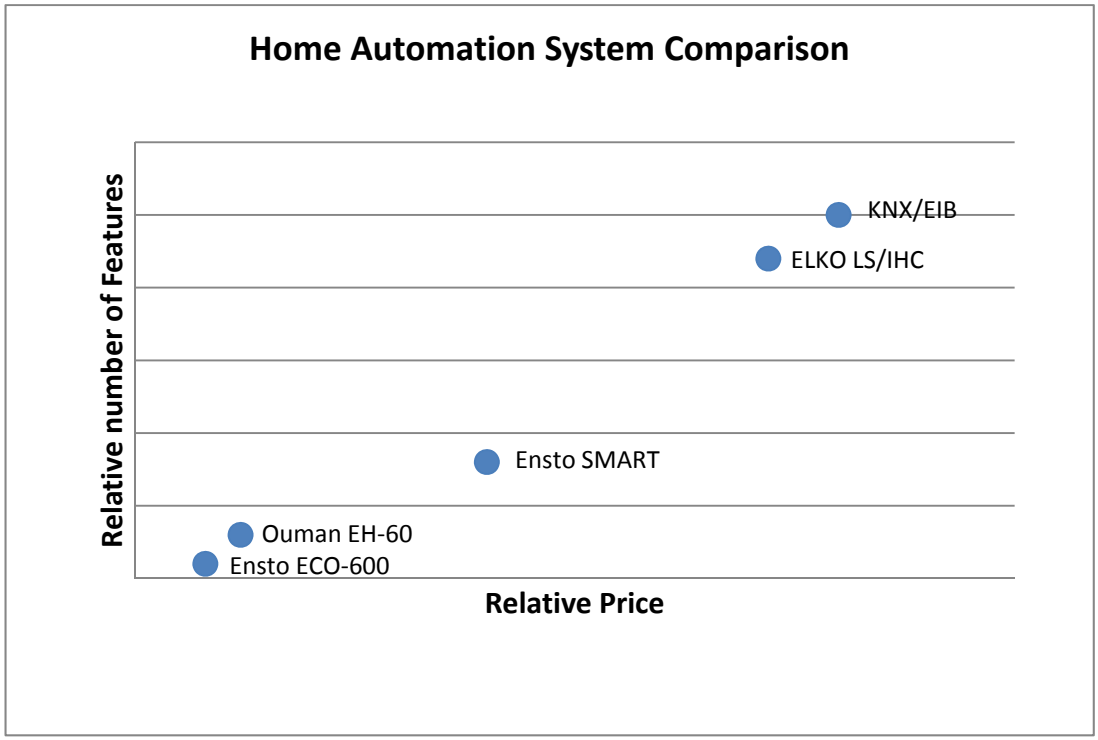

Figure 9. Home automation system comparison by price and amount of features.

3.8.1 INTEGRATED AUTOMATION SYSTEMS

The simplest home automation systems are based on small number of on-off relay controls. Such products are used to monitor and control single systems, such as heating or security systems. These types of systems commonly have mobile phone as the user interface which provides the user with easy remote control of the system. Examples of this type of products are Ensto's **ECO600** and **Ensto SMART** or Ouman's **EH-60**. They are excellent for cottage or small detached house remote controlling, for example to heat the cottage before arrival and to monitor alarms. These systems are cheapest and easy to install but they are not extendable after they have reached the maximum amount of outputs, which is often as low as 8-10 outputs.

ECO600 (Figure 10) is a simple remote control unit created especially for holiday residences. The house owner or property responsible can control heating or alarm functions by SMS messages. The system unit is equipped with a GSM modem and the user can control the system in three modes: present, away and arriving. In the present mode, all the normal settings are on and the alarms are off. The Away mode activates all the alarms and drops the heating temperature levels. The Arriving mode removes the heating temperature drop to prepare the house for use. The ECO600 system has an intelligent thermostat that can drop the heating temperature automatically for a chosen amount between 0-20 degrees. The alarms that can be integrated to the system are: general alarm, humidity alarm, burglar alarm, fire alarm and power outage alarm (Ensto, 2009b).

Ensto SMART fits slightly larger targets as it can be used to implement larger amount of on-off relay controls (16), and it has internal electrical consumption measuring and heating optimization. It can also be remotely controlled with a mobile phone. However, this product has been somewhat replaced by ECO600.

Ouman EH-60 is an intelligent home control and monitoring system for electrically heated houses, holiday residences or small business properties. The system features include remote controlling and monitoring of heating, fire alarm, water leakage control and power outage alarm, and additionally car heating, outdoor lighting or intelligent door lock control. EH-60 includes an insurance company approved burglar alarm system that can be used to implement full house burglar alarm system. The system is remote controlled with a mobile phone and has web browser control as an extra feature (Ouman, 2009).

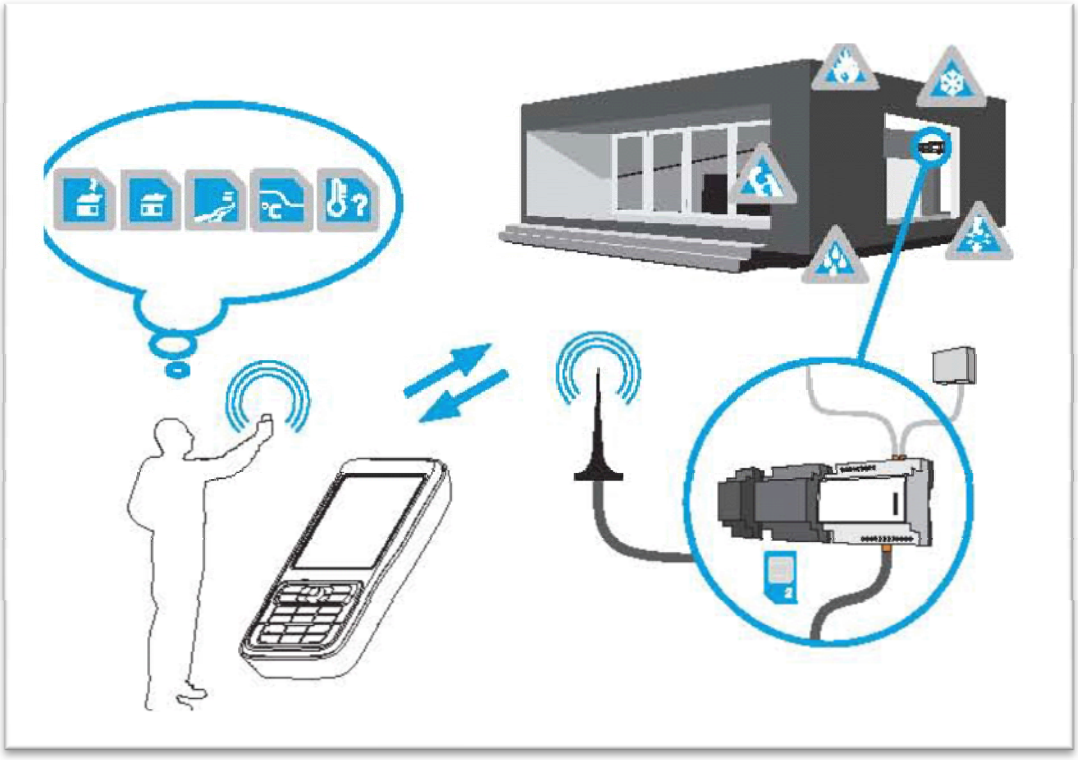

Figure 10. Eco600 home automation system principle (Ensto, 2009b).

3.8.2 HOME NETWORK AND BUS-BASED HOME AUTOMATION SYSTEMS

There are two competing full-scale home automation technologies in Finland: bus-based Konnex (**KNX**), previously known as the European Installation Bus (EIB), and Schneider Electric's star-topology based Intelligent House Control (**IHC**) which has recently been transferred to Elko and is now sold as **Elko Living System**.

IHC has been in the Finnish market for longest as it has been sold for 15 years already. The system is used for easy control of different electronic equipment, such as lighting, air conditioning, curtain motors and security equipment including burglar alarm and electrical locks (Figure 11).

IHC/**Elko Living System** works through pre-programmed settings that can be easily selected from a control panel or push buttons. It has an optional graphical user interface that can be remotely used via an Internet connection as well as through an in-house control panel. The system is built around the central unit (switchboard) and each device is connected to the switchboard with its own cable, forming a star shaped network topology.

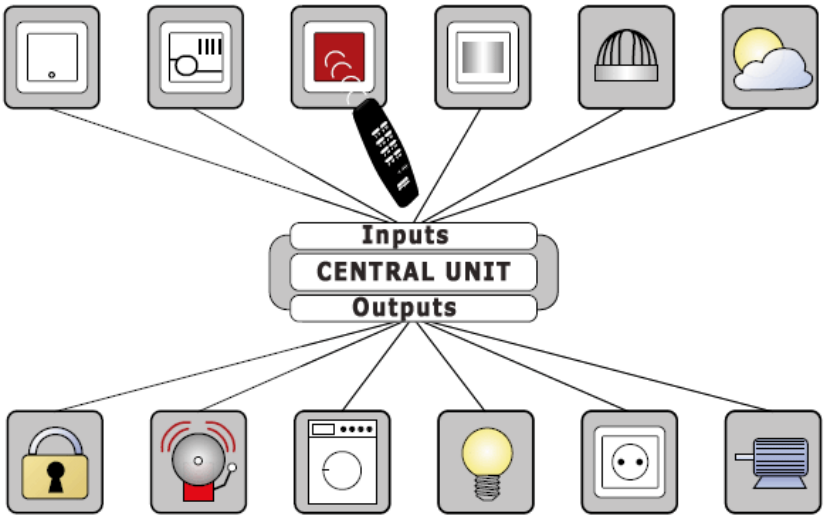

Figure 11. IHC/Elko Living System is an example of a centralized home automation system.

KNX is marketed in Finland by several device manufacturers, including Schneider Electric Finland, Ensto Busch-Jaeger (now sold to ABB), and there are importers of Dutch systems, such as Berker, Jung and Gira (KNX Finland, 2009).

KNX is a bus based home automation system that creates an energy efficient and functional network of home's electrical systems. KNX system can control all home's functions, including HVAC, lighting, blinds/shutters, security systems, energy management and audio/video control. KNX is a standardized automation system and different device manufacturers' products are interoperable.

The KNX system is built with power lines that connect up to 64 devices. Power lines can be united with a line coupler with a maximum of 15 lines per area. The system can have up to 15 areas so that the maximum amount of devices in one system is 64 x 15 x 15 = 14 400 (Ensto, 2009c). Figure 12 shows the KNX system principle.

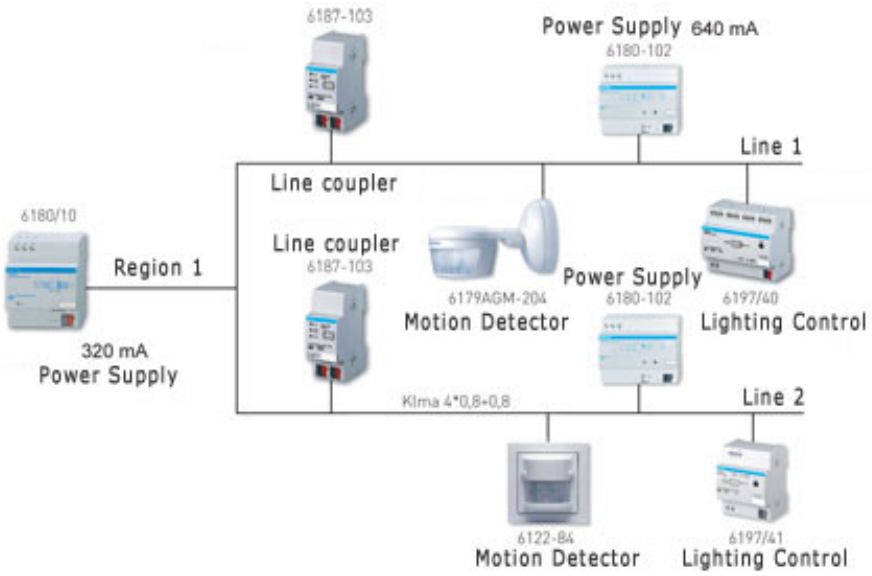

Figure 12. KNX system line coupling chart, modified from (Ensto, 2009c).

An example circuit diagram is shown in Appendix 1 for both KNX and IHC systems and a traditional electrical system. The schematic diagram shows the electrical and control wiring of a room with the different systems, the variations in cabling of the systems and the equipment needed in each system.

3.8.3 WIRELESS HOME AUTOMATION SYSTEMS

The wireless automation systems use radio frequency signals and the systems are based on push buttons and dimmers, transmitters, receivers and remote control. Simplest wireless systems are used to control lighting and some systems offer situation controlling of lighting and electrical equipment. Logical concatenation of device controls is not possible for most wireless systems, but previously presented KNX and Elko Living System offer both wired and wireless functions that will enable logical functions.

The wireless systems are exceptionally convenient in renovations or places where wiring is difficult or impossible to install, such as glass, solid stone or log walls. Most wireless systems operate on battery power, but one company, **EnOcean**, offers wireless sensor solutions that use no batteries (Martin, 2007).

Strömfors **Connect** series offers wireless switches and push buttons for lighting control. The devices can be used as part of a home automation system or as stand-alone wireless devices. The Connect wireless system has an optional control panel that can be used to implement lighting situations or timer control of devices. Multimedia control is also available with the control panel and the wireless system can be programmed with a PC (Schneider Electric, 2009).

Elko Wireless is a lighting control system for new building constructions and renovations. The wireless switches and buttons are programmed simply by pushing the programming buttons and no PC is required (Elko, 2009).

Moeller **Xcomfort** is another wireless system that can be used to develop a home automation system to cover all requirements including lighting, HVAC and shutters/blinds. The Xcomfort system can be controlled with the RF switches and buttons, remote control, mobile phone or TV (Moeller, 2009).

According to Gutierrez et al. (2003), wireless devices connected into a network, also called low-rate wireless personal area network (LR-WPAN) devices, will replace wires in home network and automation systems at very low costs. However, in Finland these products have only recently been launched in the home automation market.

4 RESEARCH METHODS

This master's thesis was conducted using Usability Engineering methods. The goal was to collect information from the stakeholders to form an insight on what kind of home automation systems are used in Finnish houses and what are the challenges in implementing the automation systems. User centered research methods offer wide range of tools to gather information about the users.

Figure 13 presents the ISO 13407 standard for human centered design process. The standard presents an iterative process for product design and gives tools to develop the most suitable results for the users. In the process the defining of user information is done before any actual designing takes place.

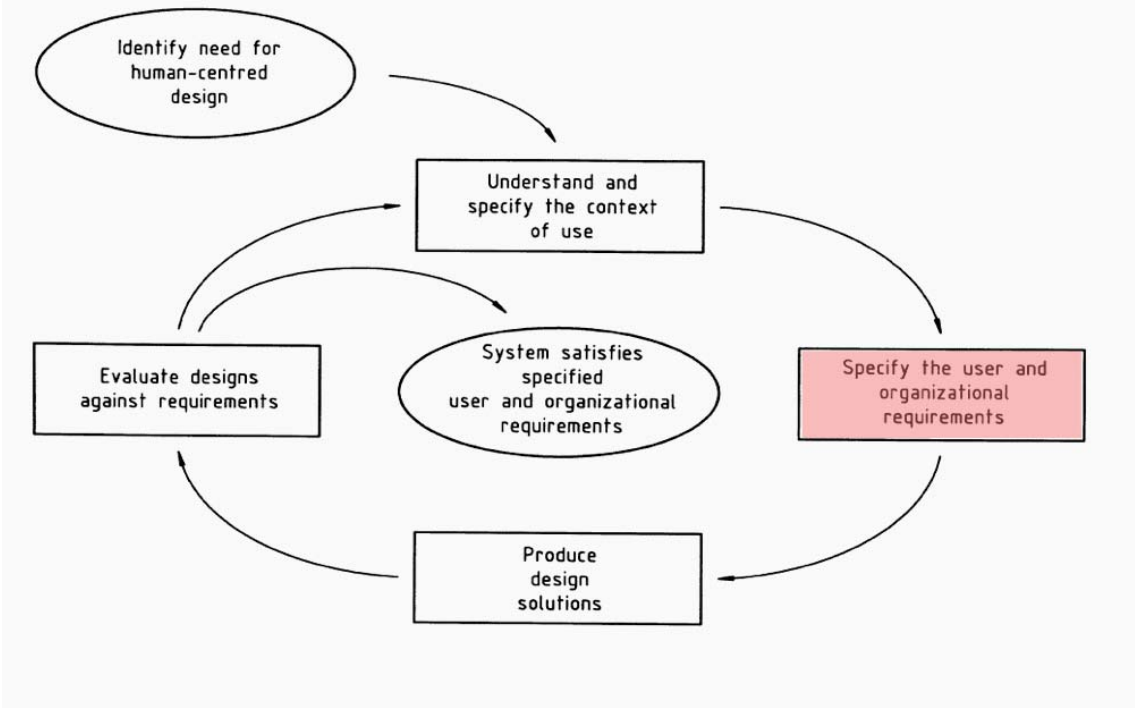

Figure 13. ISO 13407 standard for human centered design process, modified from (Pagliari, 2007).

4.1 DEFINING USER INFORMATION

According to Nielsen (1993), the first step of usability engineering process (Table 3) is getting to know the users and how they use the product. The concept of "user" is broad, including not only the end user of the product but also everybody whose work is affected by the product in some way.

Table 3. The first stage of usability engineering lifecycle model (Nielsen, 1993).

Step 1: Know the user
a. Individual user characteristics b. The user's current and desired tasks c. Functional analysis d. The evolution of user and the job

Firstly the process of knowing the user involves defining the individual user characteristics, what type of users there are, dividing users into classes or groups. If the product has distinct target market, it is possible to identify the users as concrete individuals with specific characteristics, but some products may have wide range of different users that can be very difficult to describe accurately. By knowing the users' work experience, educational level, age, previous experience with similar products, and so on, it is possible to anticipate their learning difficulties, what kind of user interface they need and what kind of problems they may have with the finished product. User characteristics are most commonly gathered with market analysis or as a side benefit from task analysis, the 2nd part of knowing the user.

Task analysis is made to research user's goals and how the users currently approach their task. The analysis can reveal conflicts in the existing product for the user to reach the desired goal and the problem can then be solved in the developed product. The goal of task analysis is to develop a model which the users apply in working their task. Suitable methods for task analysis are observation and interviewing the users.

The typical outcome of a task analysis is a list of all the things users want to accomplish with the product, all the information they need to achieve the goals, the steps they perform to reach goals and the interdependencies between the steps, all outcomes and reports that need to be produced, the criteria used to determine the quality and acceptance of the results and the communication needs of the users as they exchange information with others while performing the task.

Functional analysis concentrates on the underlying functional reasons for the user's tasks, so that the intentions are researched and not only the actual tasks. The step will reveal what the user wants to accomplish with the actions that take place.

Evolution of users and the job has to be taken into consideration as the users will learn the tasks and their use of the product changes according to their knowledge level, leading

them to use the system in new ways. Although it is impossible to forecast such changes accurately, some insight can be gained from how similar users have changed in the past (Nielsen, 1993).

4.2 USER CENTERED RESEARCH METHODS

Faulkner (2000) defines the possible research methods to gather user information as: Informal and formal discussion, Observation, Putting expert on the design team, Questionnaires and Interviews. Nielsen (1993) lists Observation, Focus Group, Questionnaires and Interviews as the usability method options for task analysis stage.

Observation is a simple tool that reveals the user's actual tasks and gives ideas on functions and features that should be developed. Interviewer visits the users to observe them work without interfering their tasks. The goal is to stay virtually invisible to the users so that they can perform their tasks as usual and give as authentic representation of their work as possible (Nielsen, 1993).

Focus group is a beneficial tool to gather information with conversations of about six to nine users together. The interviewer can act as a moderator to keep the focus of the subject using a predesigned script to coax the conversation but otherwise the conversation can be free-flowing and unstructured. Through the group interaction the interviewer can study the spontaneous reactions of the participants and how they communicate with each other.

Questionnaires and interviews are good tools for finding out the users' subjective opinions. The methods are useful for studying how the users use the product or system and what features they like or dislike. The benefit of questionnaires is that they can reach much wider group of users, whereas interviews usually are much more time consuming, which limits the amount of participants. The upside of interviews is that the interviewer can clarify the questions to the answerer and elaborate any new topics that rise from the conversation (Nielsen, 1993).

Hyysalo (2006) explains that interview questions can be classified into structured, semi-structured and open questions. Structured questions have a set of answers from which the interviewee chooses the best one, for example:

Home automation systems will become more common in the next couple of years:

I agree [] *I don't agree []* *I don't know[]*

This type of questions is most often used in questionnaires to allow easy comparison of the results.

Semi-structured questions allow the interviewee to tell the answer in his own words:

How do you define home automation?

Open questions give a broader theme or topic that the interviewee can talk about:

What would you like to tell about home automation?

With open structure both the question and answer are largely open to the interviewee's personal perception.

Choosing the interview questions is more important in the structured form as there is a risk of asking wrong questions that do not fit well to the interviewee's true opinions. Thus there's a great risk of leaving the actual topic in the dark and getting answers only to mundane issues. Research methods used in the study

All research methods (observation, putting expert in a research team, focus group, questionnaires and interviews) would have suited this study. As this study focuses on the opinions of people working in the field, it was determined that the most appropriate method of research for the subject would be personal interviews. Questionnaire was used to compare answers and to calculate statistics.

Observation was used at two building fairs where the author visited to see how the home automation products and services were marketed to customers. Observation of actual building construction sites and focus groups were considered for research methods but not utilized as they weren't possible to organize within the time frame of the study.

The experimental part was conducted by interviewing electrical designers, contractors and device manufacturers. The interviews took place at the interviewee's work or by emailing the questions to the participant, if a personal interview was not possible. Interviews were recorded with a digital recorder. Additionally a questionnaire was made for the participants to survey their opinions with a scale of 1-5 for statistic keeping.

4.2.1 OBSERVATION

As the actual building sites were not possible to observe during the thesis work, observation was used to gather information from building fairs where consumers acquire information about house constructing. The building fairs were chosen to view the home automation market from the client's perspective. The purpose was to observe home

automation professionals as they market the devices. Other tasks at the building fairs were to gather material of different home automation systems that were marketed for consumers and to get new contacts for further interviews.

4.2.2 THEME INTERVIEWS

Device manufacturers were interviewed with open interviews and conversations to gather information about different themes regarding home automation systems and the manufacturer's opinions about the challenges in home automation field. The interviews had no set of questions and were recorded with digital recorder for reference purposes. The interviews were mostly conducted before the semi-structural interviews. The results from the device manufacturers intervies were used to develop questions for semi-structured and structured interviews. Another priority in the theme interviews was to familiarize with the different types of home automation systems in the market.

4.2.3 SEMI-STRUCTURAL INTERVIEWS

The purpose of the semi-structural interviews was to research the challenges of home automation from the electrical designer's, electrician's and contractor's point of view. The interview results were each interviewee's personal opinions. All the participants had long experience in the industry so they had formed a good view of its present state.

The interview questions were determined after the initial open interviews with the equipment manufacturers. Preliminary telephone interviews were conducted with three contractors and one question list was emailed to a contractor to test the questions. The final set of interview questions in Finnish is listed in Appendix 2, and the results are in Appendix 4.

Many of the challenges concerning building contracting were known by the device manufacturers before the interviews. However, the challenges and attitudes were clarified by the interviews and questionnaires.

4.2.4 STRUCTURAL INTERVIEWS

Structural interviews were conducted in the form of an Internet questionnaire. The questions were determined from the material gained from the initial open interviews with the device manufacturers. Questionnaire was written in the form of multiple-choice questions. The questions were formed in phrases of personal opinion regarding the home automation systems. The questionnaire form is presented in Appendix 3.

4.3 USER GROUPS IN THE STUDY

The stakeholders of the study were divided into four user groups: electrical designers, electrical contractors, electricians and device manufacturers. Their relations are shown in Figure 14.

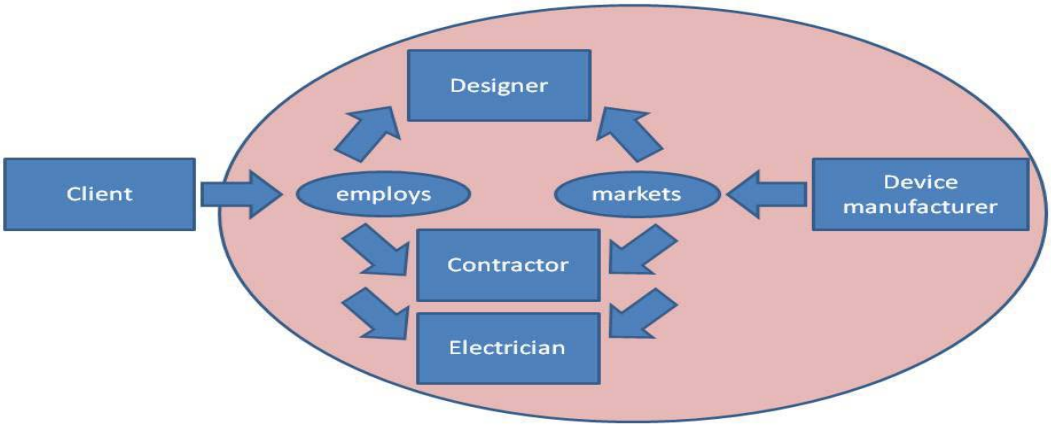

Figure 14. User groups in the study.

The interviews were targeted to the electrical contractors and designers. Most of the electrical contractors had technician's or installer's education and experience on electrical installations. They were able to speak from both electrical contractor's and electrician's point of view. Further information on interviewees is presented in Chapter 5.2 Background of the interview participants.

Since the study received only a small amount of replies, the results were processed from the collective point of view of all the four user groups. The essential differences in replies were divided between the user groups when applicable.

5 IMPLEMENTATION OF INTERVIEW STUDY

The study was made using four different research methods. Main research material was gathered from the (semi-structured) personal interviews. Additional material was acquired with questionnaire (structured interview), theme interviews and observation. Both a semi-structured interview and a structured interview were used to interview electrical designers and contractors (see Appendix 2: Interview questions and Appendix 3: Questionnaire) and theme interviews were conducted with device manufacturers. Observation at Finnish building fairs was used to collect information about the home automation systems. All interviews were made in Finnish.

The participants to interviews were searched using Internet, the main channels were STUL's constructor search page (STUL, 2008) and SLO Professionals' Wholesaler website "Mukavammin sähköllä", which included an electrical professional search for consumers (SLO, 2009). All participants were contacted via phone to get higher answering rates than with emails or letters.

5.1 STRUCTURE OF THE INTERVIEWS

The interview questions were divided into five categories and all questions were presented to each participant regardless of their occupation, giving each person an option to answer the themes they were familiar with. The question categories were: Home automation, Electrical design, Building (electrical) contract, Installation of home automation systems, Clients and Project results.

The questions were formed in such a way that information was received according to the usability engineering process of getting to know the user (presented in Chapter 4.1): the interviewees' background, their work tasks, the goals they wish to accomplish with their work and their level of expertise in the field of home automation.

The questionnaire followed the same structure and was written in the form of statements or personal opinions which were given with Likert scale of 1-5, to measure the answer on an interval:

5: Strongly agree, 4: agree 3: neutral, 2: disagree, 1: strongly disagree.

5.2 BACKGROUND OF THE INTERVIEW PARTICIPANTS

A total of 24 electrical contractors, nine electrical designers and five device manufacturers were contacted, resulting in 38 possible interviewees, and in the end 24 participants were accumulated. The participants are listed in Appendix 6.

The interview participants' answers are presented in Figure 15 according to the user groups in the study. A total of 29 replies were received from 24 distinct participants.

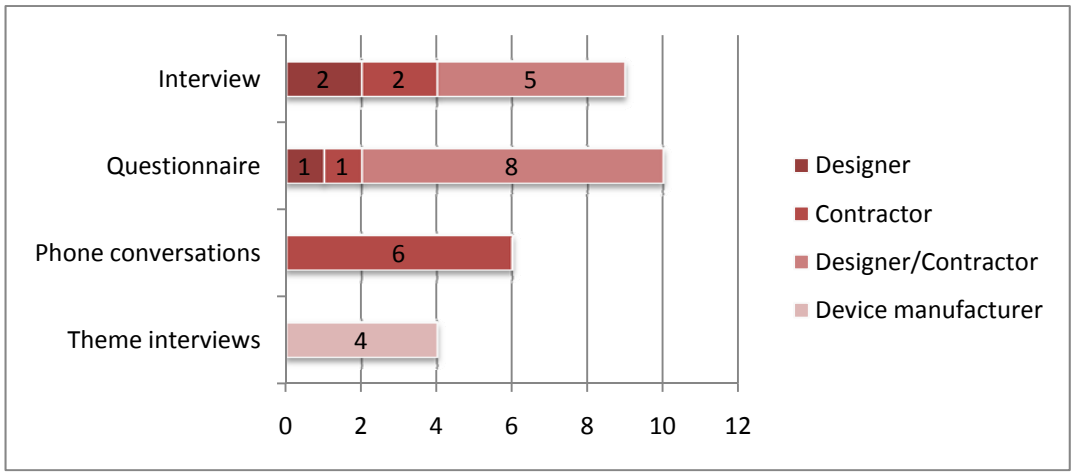

Figure 15. Interview study replies divided in user groups.

The semi-structured interview had nine participants, two of which were electrical designers, two electrical contractors and five were electrical contractors that also had experience in electrical design.

The questionnaire received 10 answers, including one from an electrical designer, one from an electrical contractor and eight from contractors who had experience of electrical design.

There were five people who answered both questionnaire and interview questions, including one electrical designer, one electrical contractor and three participants who had experience of both.

The theme interviews with device manufacturers resulted with four company interviews: Ensto Oy, Schneider Electric Finland Oy, Berker (DJS Automation Oy) and Elko Oy. STUL was interviewed regarding their interest to help the electrical contractors in the home automation field.

Furthermore, six short phone conversations were made with contractors that had mainly negative or neutral outlook towards applying home automation and did not want to give an "official" reply to the interview. However they pointed out many of the same challenges that the interviewees albeit in more pointed fashion.

The educational backgrounds of the interviewees varied from engineers and electricians to technicians. Two of the interviewees did now want their education listed in the study

and one interviewee only included his current job position but no educational information. The interviewees' education diagram is shown in Figure 16 a) and b).

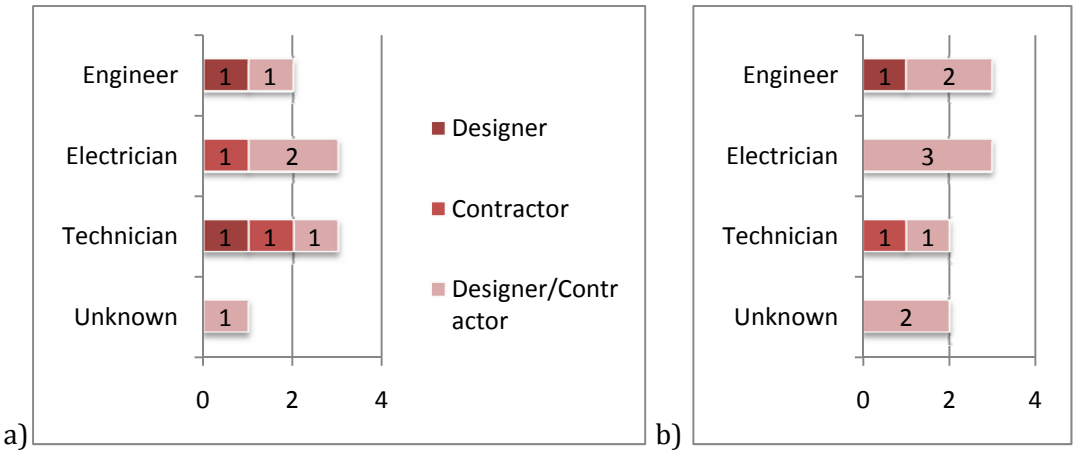

Figure 16. Educational background of a) interview and b) questionnaire participants

The interview participants gave different opinions about home automation and its usefulness in general. All interview participants had positive outlook on the systems, whereas one questionnaire answer had negative and one neutral air, and from the additional phone calls two were negative and three neutral towards the home automation (Figure 17).

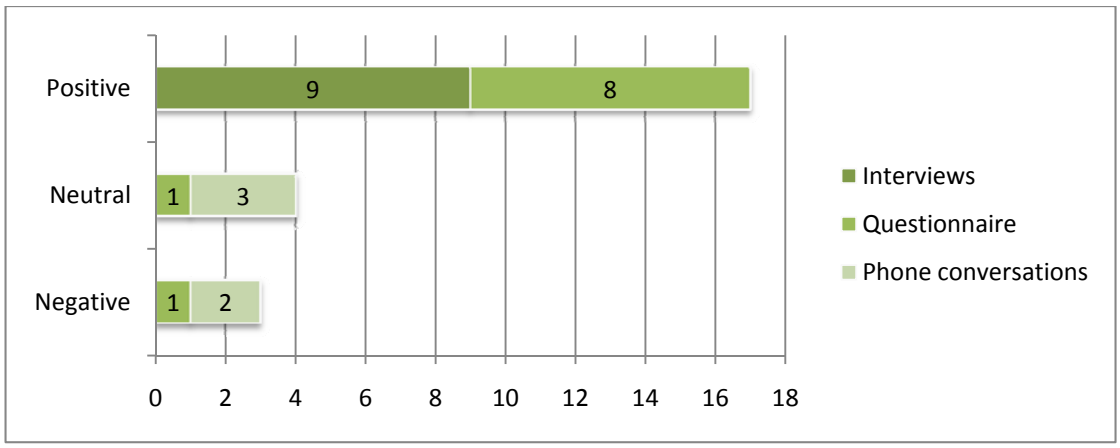

Figure 17. Interviewees' position on home automation systems.

5.3 Organizing the semi-structured interviews

The semi-structured interviews were arranged during several months, as the contractors' schedules were often very busy. The participants were contacted via telephone calls to the companies that advertised electrical contracting, automation contracting or electrical design services. The companies were mostly selected from southern Finland to better

accommodate personal interviews, but one reply was received from central Finland by email.

For the interviews a total of 24 electrical contractors were contacted which resulted four recorded interview sessions. A total of five electrical designers were contacted for the interviews and all of them agreed to participate in the interviews. Interestingly, it was much easier to "recruit" designers than contractors for the interviews. Getting participants with negative position for the interviews proved to be difficult, thus the majority of negative comments were gathered through short and unofficial phone conversations.

5.4 ORGANIZING THE STRUCTURED INTERVIEW

Questionnaire was made to gain knowledge of respondents' individual opinions in an easy format that could be measured. A total of 10 replies were received of which five were from the same participants than in the interviews and five replies came from distinct participants who did not want to answer the interview questions due to lack of time. One of the answerers was an electrical contractor, the nine rest had experience in both electrical design and contracting. Of the questionnaire replies one was from western Finland and the rest were from southern Finland.

In the questionnaire, the average and median work experience values for the participants were quite high, on scale of 1 to 5, the average and median of the experience in traditional electrical systems was 4 or above, meaning more than 4 years of experience. Median for traditional electrical system contracting and installations was 5, meaning over 10 years of experience. This indicates that the interviewees were experienced in their profession.

Table 4. Work experience of questionnaire participants.

5= over 10 years, 4=4-10 years, 3=2-4 years, 2=under 2 years, 1=none.

Traditional electrical systems	Average	Median
Traditional design	4	4.5
Traditional contracting	4.2	5
Traditional installations	4.5	5
Basic automation systems	Average	Median
Basic automation (Ensto SMART, ECO-600) design	2.3	2
Basic automation (Ensto SMART, ECO-600) contracting	3.1	3.5
Basic automation (Ensto SMART, ECO-600) installations	3.1	3.5
Bus based automation systems	Average	Median
Bus based automation (KNX/EIB/LON) design	2.6	2.5
Bus based automation (KNX/EIB/LON) contracting	2.6	2.5
Bus based automation (KNX/EIB/LON) installations	2.6	2.5
"Smart house" automation systems	Average	Median
"Smart house" design	2	1
"Smart house" contracting	2.6	2
"Smart house" installations	2.6	2
Wireless automation systems	Average	Median
Wireless automation design	2	2
Wireless automation contracting	2.4	2
Wireless automation installations	2.4	2

5.5 ORGANIZING THE THEME INTERVIEWS

Theme interviews were conducted as open conversations with device manufacturers. They were made to find out the device manufacturers' point of view as well as to find out the technologies related to their products. Most of the device manufacturer interviews

were conducted prior to interviewing electrical contractors and engineers. The material gathered from the device manufacturers was used in drafting the interview questions.

A total of four device manufacturers were interviewed: Ensto Oy, Schneider Electric Finland Oy, Berker (DJS Automation Oy) and Elko Oy.

5.6 ADDITIONAL PHONE CONVERSATIONS WITH ELECTRICAL CONTRACTORS

Reaching willing participants for the interviews was not easy and getting answers from people that had negative position on home automation was even more difficult. However, many interesting comments were received from the phone calls with contractors who had negative or neutral perspective towards home automation. Those comments are listed in Appendix 6.

5.7 OBSERVATION OF BUILDING FAIRS

Two building fairs were attended by author during the spring 2009: OmaKoti/OmaMökki (OwnHome/OwnCottage) fair at Helsinki Fair Centre March 26th-29th, 2009 and Rakentaminen ja Talotekniikka (Building Construction and Technology) fair at Jyväskylä Paviljonki March 6th-8th, 2009. Home automation professionals were observed from the client's perspective, material of different home automation systems was acquired and two new device manufacturer interviews were settled during the fair visits (Figure 18).

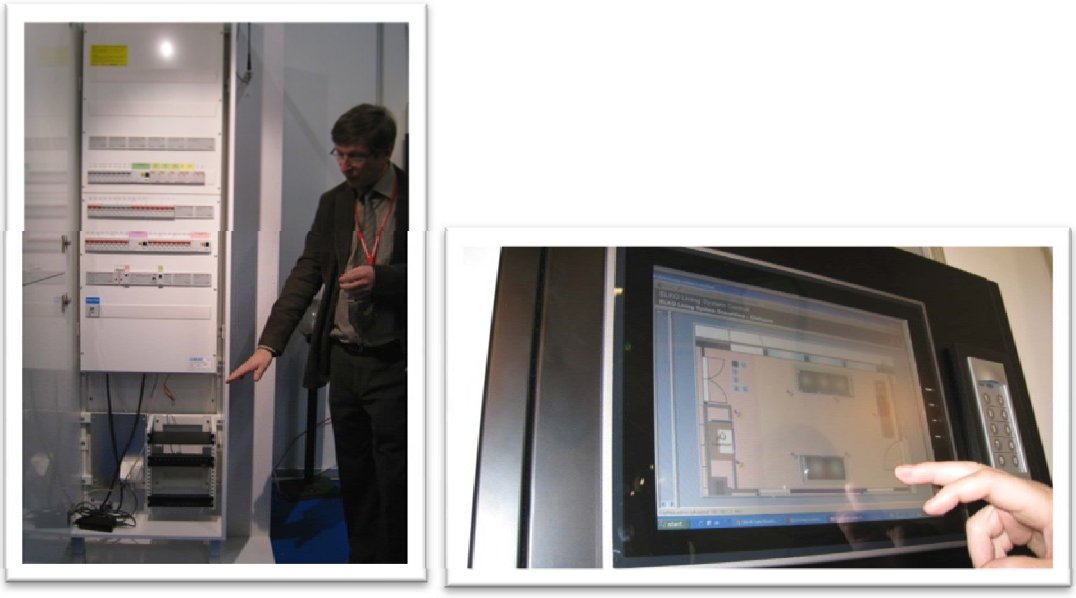

Figure 18. Elko living system wireless home automation with Selega switchboard presented at the Jyväskylä building fair.

6 RESULTS OF THE INTERVIEW STUDY

This chapter presents the results of the interview study. Both interview results and questionnaire results are combined according to the interview structure. Additional phone conversation results are presented in their own chapter due to the contrast of the phone conversation results in regard to the rest of the interviews.

6.1 HOME AUTOMATION

When defining home automation systems, half of the interview replies mentioned lighting control, three out of eight mentioned HVAC systems being controlled and half of the replies mentioned that the automation system should be one whole system instead of several separate systems. Only one reply considered integrated automation systems as part of home automation, whereas most replies regarded them as not being "real" automation at all.

Most of the interviewees only had one or two detached houses per year to utilize automation systems and only two out of the eight answerers installed these systems into nearly every house project (See Figure 19).

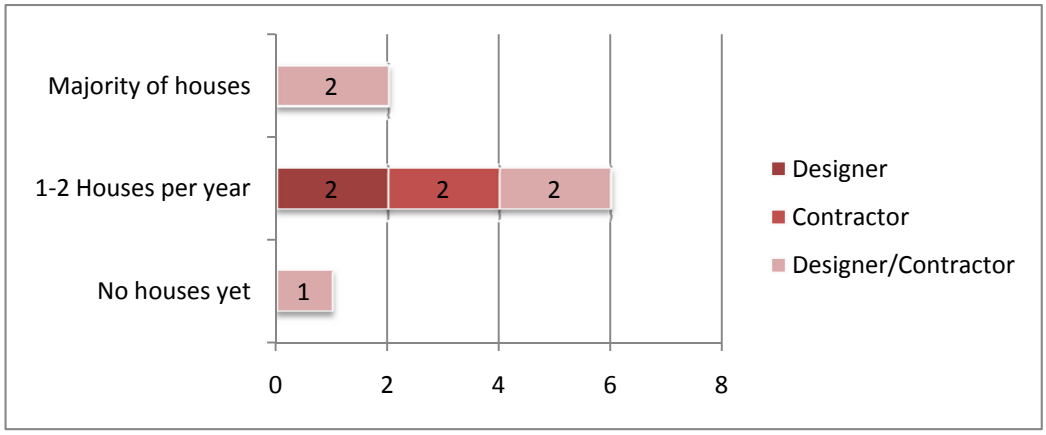

Figure 19. How often home automation is used in house projects? 9 replies.

Concerning detached house building projects, bus based KNX/EIB was most commonly mentioned. IHC or Elko Living System was the second most often mentioned system. One of the nine answerers had never installed any automation systems and was only aware of simpler systems, such as Ensto ECO-600 or Ensto SMART (Figure 20).

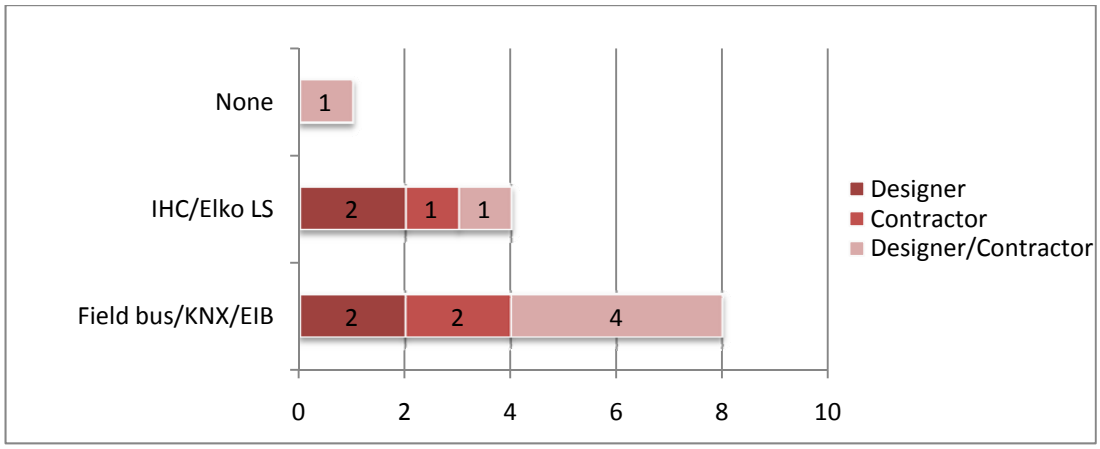

Figure 20. What type of home automation systems you use in homes? 9 replies.

When choosing a home automation system, majority of contractors replied that it is the electrical designer who chooses the appropriate system. Designers confirmed that they select the suitable option with the client. The system's manufacturer, ease of installation or design and price were contributing factors in choosing the system (Figure 21).

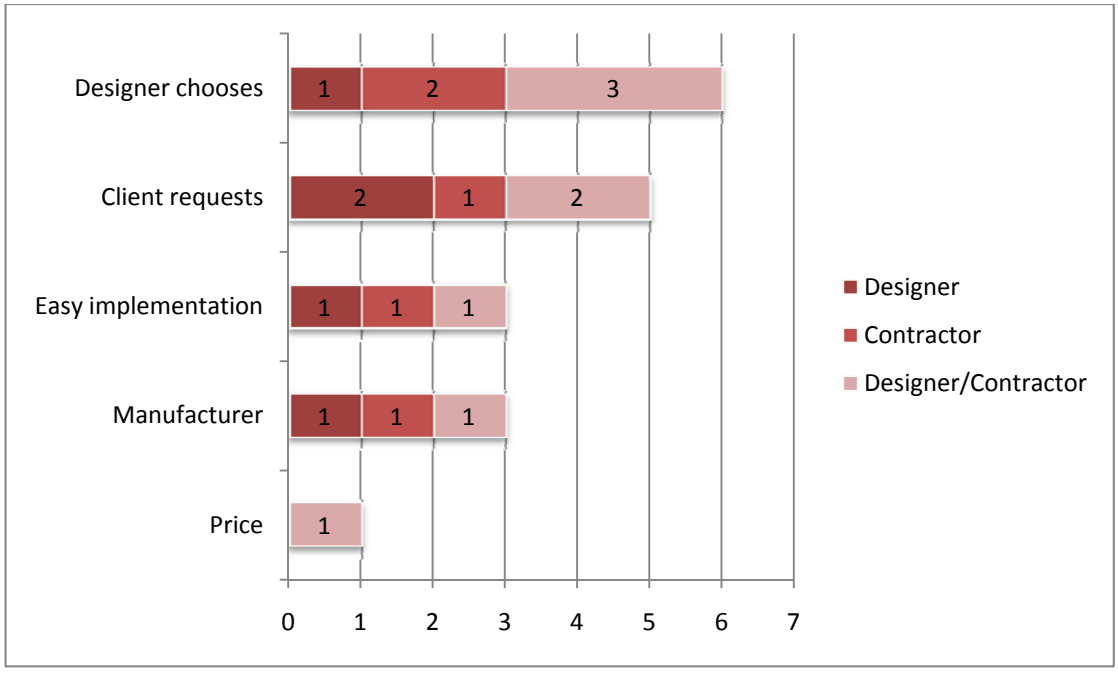

Figure 21. Contributers on choosing the home automation system.

The contractors mainly realized home automation systems of a single manufacturer, whereas designers were able to apply the system that client chose. From the device manufacturer Ensto EIB/Busch-Jaeger was most frequently mentioned, then Berker KNX and Strömfors IHC/Elko Living System. (Figure 22).

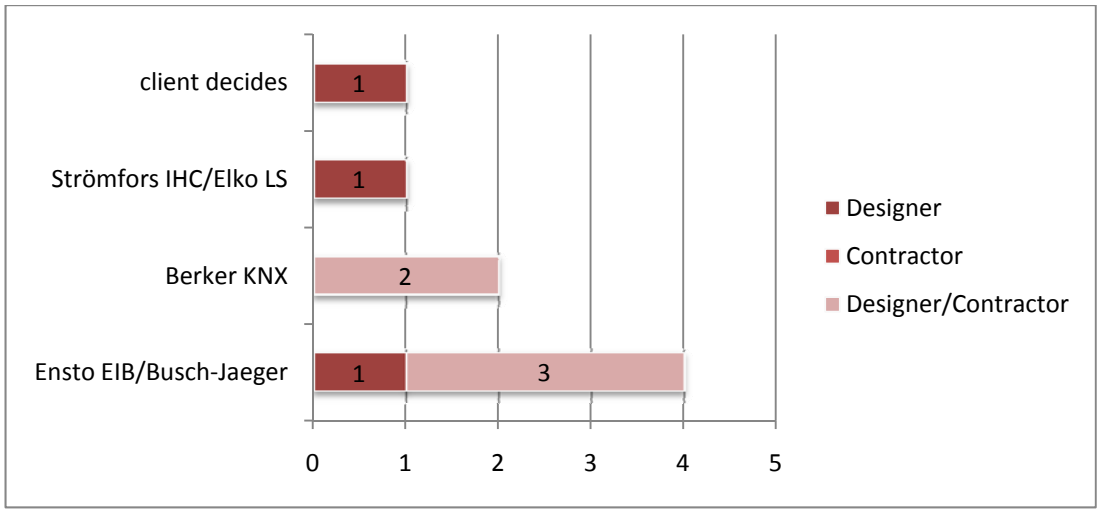

Figure 22. Which device manufacturer's products you use for home automation systems? 5 replies.

The benefits of home automation were numerous according to replies: increased comfort, versatility and convertibility of the system, energy saving, centralized control of the house, safety and extensibility of the system (Figure 23).

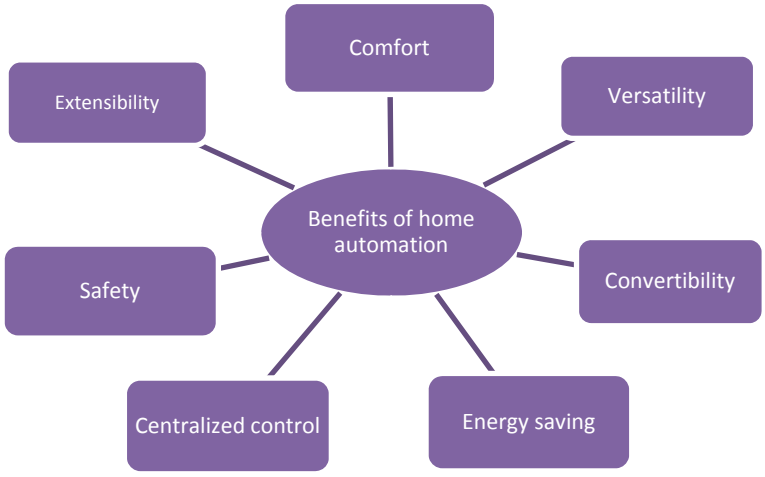

Figure 23. Benefits of home automation.

Wireless home automation systems received many benefits and disadvantages in comparison to wired automation systems or traditional electrical systems (Figure 24). The most suitable application for wireless systems was considered to be renovations and

difficult mounting surfaces, such as log or glass walls. Battery power was the strongest negative in wireless systems and piezoelectric implementation was considered a much better solution. In the questionnaire the wireless systems were not considered cheaper or more expensive in full-scale realization than wired systems but the interview replies noted that the components were much more expensive than wired components.

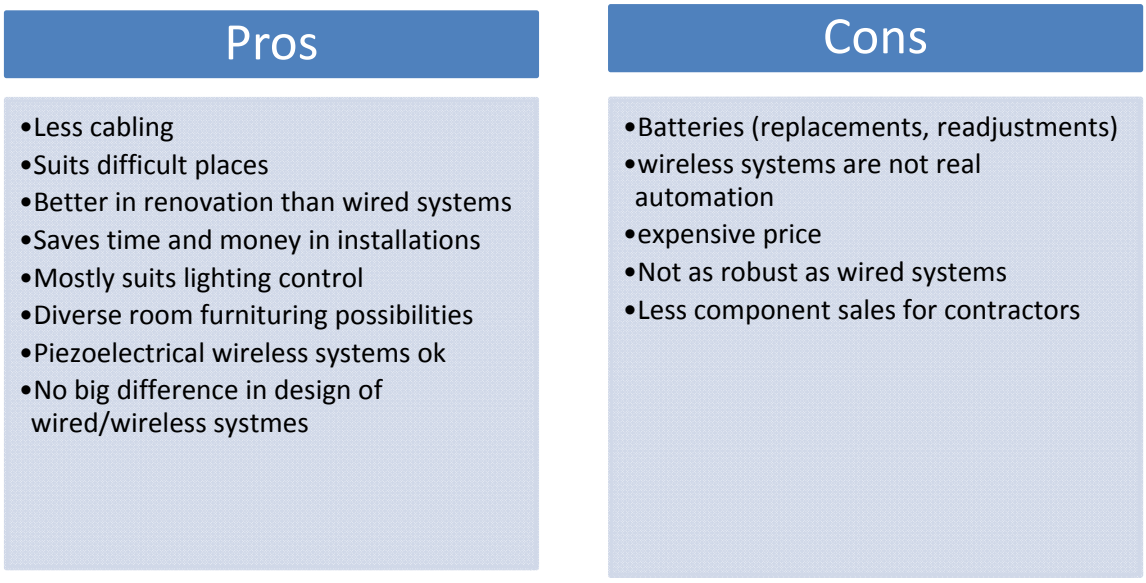

Figure 24. Benefits and disadvantages of wireless home automation systems.

When asked who is responsible for design, programming, installations, education and maintenance of a home automation system, the responses showed the differing business models for the interviewees. Among 9 replies there were three contractors whose companies offered "whole package" service including electrical design and maintenance. Another concept was to offer contracting and outsource programming to the company that produces switchboards according to the design drawings. Third type was to offer contracting, programming and maintenance. The two interviewed designers offered only design services. Third designer, who also did small scale contracting, confirmed that the programming is the contractor's responsibility and their company had outsourced programming due the lack of time to learn it. Fourth designer distributed the responsibilities so that designers should do the whole documentation and volume counting and contractors should have responsibility of quantity calculating and realizing the system according to the design plans.

6.2 BUILDING ELECTRICAL DESIGN PHASE

Home automation systems were included only in design of detached houses that were larger in surface area or were otherwise better equipped than average houses. The electrical design phase included meetings with clients to discuss their needs and expectations. The designer then created the electrical documentation according to the meetings. According to all replies, the home automation system needs to be taken into account from the early stages of the design phase.

The electrical design should include project description, electrical wiring plans, electrical power plans, panel drawings and diagrams concerning electrical and electronic systems (antenna, universal cabling, burglar alarm and fire alarm diagrams), light catalogue, and if the HVAC drawings are available, the design should include HVAC catalogue and any electrical drawings that are necessary for HVAC functions. The project description should contain detailed information about the home automation system, including the programmable features of the system.

The contractors criticized that often the electrical designs they receive are not adequate to allow successful implementation. Contractors had to make changes in the electrical design plans and sometimes found it difficult to interpret the programmable functions of the system when the documents did not include enough information. According to one reply, only third of the electrical documents received were sufficient and two thirds were of low quality.

The design phase of the home automation system normally ended in tender documents that the client sent to request electrical contract offers. Alterations to the documents and drawing of final electrical documents were conducted by the electrical contractor.

The tender documents most often did not include quantity calculations, a document that defines the amount of equipment and cabling in the floor plans. At least approximate quantity calculations are available in most computer aided drawing (CAD) programs according to the interviewees. Electrical designers responded that the client has to specifically order quantity calculations from the designer and neither of the designers had included them in documentation of houses. Four of the five replied contractors preferred that designers should include calculations in the drawings. One of the contractors felt that quantity calculations should be done by contractors because the designer does not have similar experience in the actual building process and thus does not know the most suitable

cabling routes and equipment placements. The design programs were also criticized of not taking into account the heights of the installations causing inaccurate cable lengths.

6.3 BUILDING ELECTRICAL CONTRACT PHASE

The electrical contracting has mostly remained the same during the past 20 years according to the interviewees. The industry is very conservative and most of the houses are built with tight budgets using traditional electrical systems. Lighting applications have started to interest homebuilders and, overall, clients are willing to use more money on their houses than before. Wireless systems and automation systems have slowly increased in number and security solutions have raised interest.

Some of the electrical design procedures have been transferred into contractor's responsibility, namely quantity calculations and final documentations. The electrical contract phase starts with sending tenders to the prospective clients. The contract price is usually determined with quantity calculation. Another method is giving the client a price based on the square meters of the house. The second option is rare as it is very difficult to calculate appropriate price that fits several building projects because each building project is unique. The quantity calculation requires manual counting of devices from the electrical documents and is performed by each contractor to submit a tender to a certain house project. The winning contractor will then realize the electrical systems of the house according to the documentation and their quantity calculations. According to the questionnaire, it was difficult for contractors to form an accurate contract price and any extra equipment not taken into account in quality calculations ended up as additional cost to the client.

6.4 HOME AUTOMATION INSTALLATIONS

When asked about electricians' knowledge on home automation system installations and whether there is a need of special knowledge to install systems, the answers were divided. The interviewees mainly felt that the systems were not so complex that with good instructions and documents the electricians should have no problems when installing the equipment (Figure 25). Negative comments were given on older electricians who usually had less knowledge about automation systems. Other issues were the amount of different systems that needed to be learnt and the lack of proper instruction documentation from device manufacturers. Programming was mentioned as a problem as it requires special knowledge.

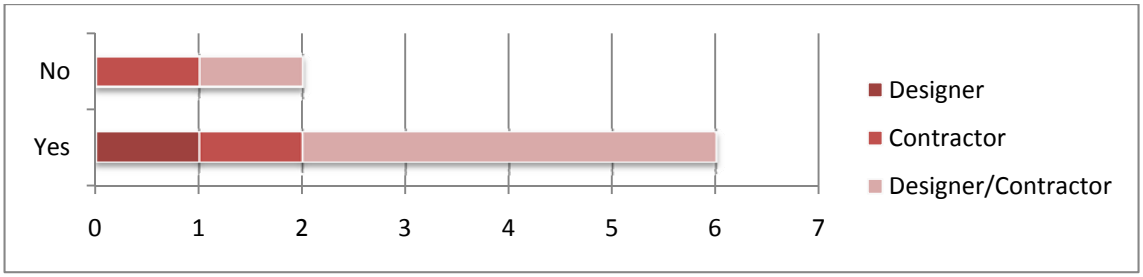

Figure 25. Do all electricians have enough knowledge to install home automation systems (8 replies)?

In the questionnaire the participants felt that the installations require special experience and that it was difficult to find suitable installers who had experience in automation installations. The system installations are learnt by doing rather than in school. The questionnaire replies requested more specific education about home automation systems and improved guidelines and installation instructions.

The biggest problem in installation phase of a home automation system is the integration of different electrical systems and devices, for instance connecting an air control machine to the system or getting feedback data out of a ground source heat pump. Programming was another major concern mainly because of the installers' lack of routine due to the small amount of home automation installations.

6.5 CLIENT FEEDBACK

Clients gather information of home automation systems mainly from building fairs and Internet. According to the interviews the most important system features for the client were lighting control and HVAC control. Also on-off switch (home/away function) and security systems were mentioned. Two replies speculated that the situation controlling was not used much in homes.

When asked about client's point of view on home automation systems the interviewees offered several reasons why the client would want such system (Figure 26).

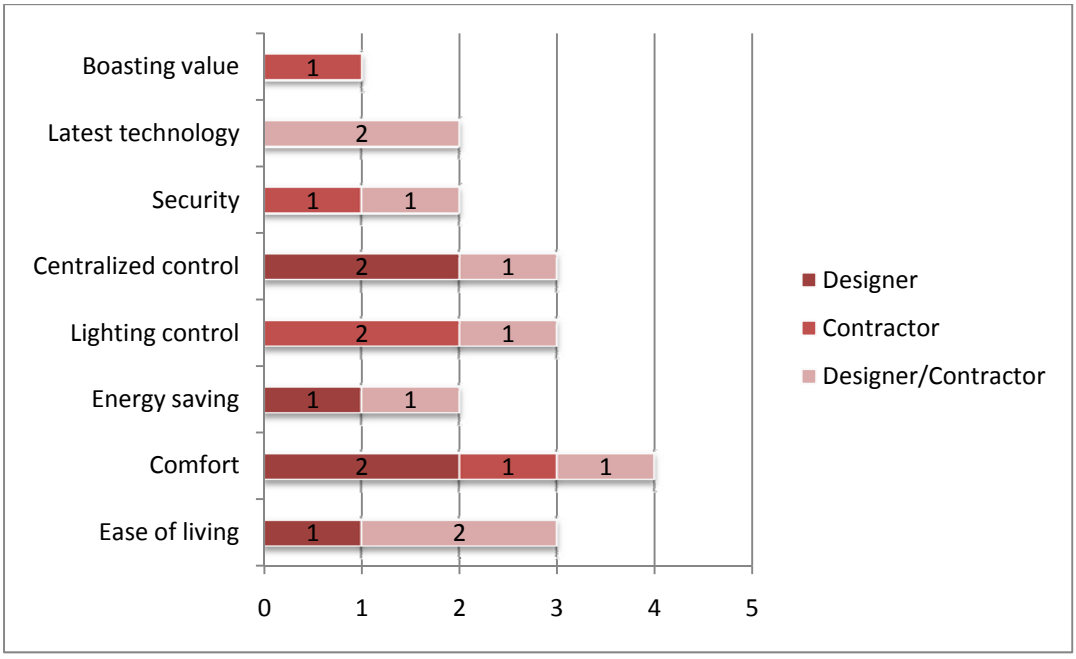

Figure 26. Reasons why clients want to use home automation (9 replies).

Interviewees hoped for more marketing of home automation systems towards clients and electrical designers. Marketing of home automation systems should be done by device manufacturers and automation system organizations such as KNX Finland. Most of the clients had no information about the systems beforehand and the lack of information was considered one of the biggest problems according to the interviewees. Some interviewees felt that clients knew the systems quite well through building fairs and other research but usually even the purpose of the system had to be explained to less knowledgeable clients.

6.6 PROJECT RESULTS

Regarding the project results, there were several interesting comments. Most notably contractors seemed to tie the results directly to the quality of the design plans, thus good designs equaled good project results. Secondly, the two interviewed designers commented that they had no idea how the projects succeeded. Their only form of feedback was negative, and in the absence of feedback, they speculated that there were no problems in the projects. However contractors claimed that they rarely ever contacted designers unless there were drastic faults in the documentation, any smaller errors they would simply fix themselves. Lastly the contractors claimed that the results were dependent on how well the client's expectations were discovered in the early design phase and how well the possibilities of the system were explained to the client.

The demands of both electrical contractors and designers were formed from the overall replies of the interviews. In order to successfully complete a home automation project the designers and contractors had to complete several goals that are represented in Figure 27.

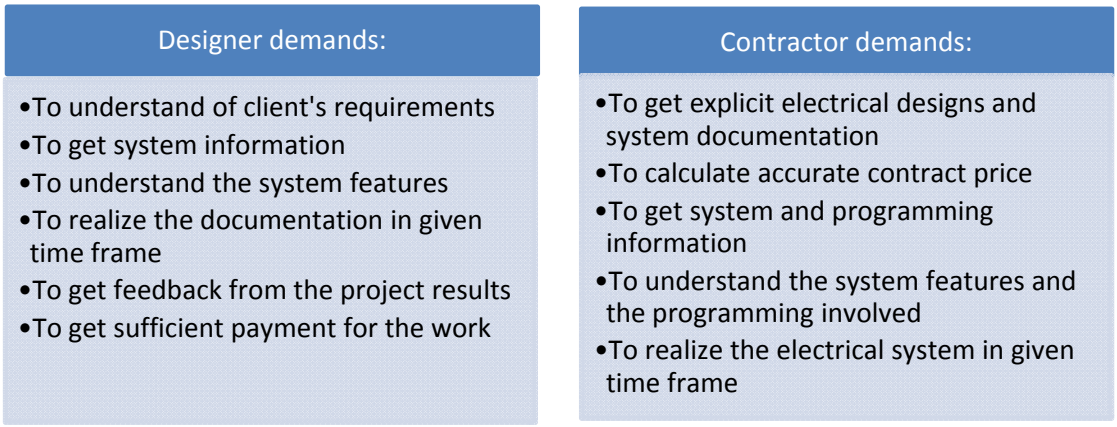

Figure 27. The demands of electrical designers and contractors in a home automation project.

The biggest issues that prevent home automation systems to become more common were the lack of marketing of the new technologies, absence of proper education of designers, contractors and electricians, conservativeness of the industry, high price of the systems and the lack of comprehensive service for clients. The clients do not trust the systems and it is difficult to sell the systems with simply ease of use as the main benefit.

The professionals need some incentive to adopt the new technologies. At the moment the only reason for contractors and designers to learn and implement these systems is self-teaching as the system realizations are still so uncommon. The interview results suggested that the home automation contracting is not yet profitable enough and that most of the contractors are solely improving their competitiveness for the future, when the home automation systems will become more common.

According to the questionnaire the respondents felt that the benefits of home automation are still few compared to the costs. Still the electrical systems in homes were considered to increase in number and develop into intelligent automation systems rather than cheaper relay-controlled systems.

6.7 Additional phone conversation results

The additional phone interviews showed criticism towards the home automation systems. The main concern was the systems' high price that homebuilders were not ready to pay, especially as most of the clients were already bargaining with construction prices. It was questioned if the clients have liquidity for the higher costs and if it would become an issue

in the end of the construction project when the client is out of money and the electrical contractor is the last to get his money back.

The electrical design of home automation systems was criticized as being less than adequate to form accurate electrical contract price. The alterations are expensive during the construction site stage and the client would definitely not agree to pay for the extra fees, the systems simply were not seen to be worth the trouble and the risk.

Home automation was regarded as luxury that most clients will not be interested in. Also the systems were considered so complex that they are only suitable for clients who like gimmicks and experimenting with technologies, "Gyro Gearlooses might be interested in those systems". Then again the systems were not considered as fancy as they are imagined to be, causing the clients to possibly have unrealistic expectations.

The contractors of bigger companies thought that home automation or home electrical contracting market is only profitable for small companies with one to five electricians, "the Hiace-men", as the home construction is seasonal work and for a larger company there would be countless work sites that would be impossible to keep up with.

The most suitable application of automation was considered HVAC systems that could improve energy efficiency.

Wireless systems were regarded as the upcoming products but they were also considered unprofitable for electrical contractors, as the switches do not require professional electricians to install and the batteries will need changing, which wasn't considered reasonable, "Electrical wiring will last at least twenty years".

7 ANALYSIS OF RESULTS

This chapter discusses the results from the Chapter 6 and the major findings of the research. The chapter presents the challenges of home automation and further explains some of the issues with case examples of two home automation project outcomes from the client's perspective.

The interviews reflected that the home automation field is scattered and lacks consistent work practices. There is a need for home automation integrators who connect different electrical systems and take responsibility over the system realization. For the homebuilder the situation is quite difficult. They must first find information about the home automation systems, then not only employ professionals to design, install and maintain their electrical systems but in particular employ the correct people who know about automation systems and can integrate the different electrical systems into a single operative system.

According to the interviews made for this thesis, the best results within the home automation system providers came from co-operation of designers and contractors when the client could get the entire system easily from one company.

Interestingly it was the electrical contractor who most often acted as the integrator of home automation systems and who also made the electrical design plans for the house. Conflicts occurred when the client had employed and paid the electrical designer before seeking the electrical contractor, which often resulted in the worst case scenario: inadequate electrical plans that were not useful for the contractor to develop the automation system. To improve the situation, the contractors should either co-operate with designers to get the practical knowledge of the systems into the design phase or offer their own design services. Overall, clients need to be informed about electrical design documentation requirements in such a tangible manner that they know to demand proper documentation from the electrical designers.

The division of design and contracting into two separate projects greatly hinders the implementation of home automation systems. In order to better serve customers the systems should be sold in projects, not as sub-projects as it is done today. It is very unfortunate that the house construction is divided into such small segments that nobody has the control over the big picture and in such there is a need for an integrator who can take responsibility of the entire home automation system at least. The automation systems can control not only the electrical systems but also HVAC systems and co-operation with HVAC designer and contractor is also needed from the integrator.

7.1 HOME AUTOMATION

The interviewees were very opinionated about the different home automation systems and had strong points favoring the system that they used and negative feedback on the other available systems. The electrical designers were more open about designing the system that client wants whereas the contractors had mostly learned one or two optional systems.

The benefits of home automation were many according to the answerers. The top three benefits were increased comfort, versatility and convertibility of the system, and the possibility to save energy. Other benefits that were mentioned were centralized control of the house, safety and extensibility of the system.

Wireless automation systems divided opinions between contractors and designers. Designers did not see much difference in designing wired or wireless systems and their major concern was the higher price of the wireless devices for the client. Contractors had many concerns towards wireless systems. The systems were mostly regarded appropriate for lighting control and for difficult locations where cabling was not possible, such as log houses or glass walls. The most acknowledged use for wireless automation systems was in renovation of houses where no walls can be torn down. Wireless automation reduces the installation time and the cable costs in the house but some contractors felt that wireless installations weren't reliable enough for such a fundamental installations as electrical wiring. Also they felt that cabling is the basic job of electrical installations and they seemed to fear the lack of work if wireless systems were used instead. "Anyone can install wireless switches" and "we get higher component sales with fixed installations, and it is not profitable to use wireless" were comments that reflect some of the concerns of the contractors.

Most complaints about wireless systems came from their use of battery power and the need of battery change eventually. It was not considered reasonable to switch batteries for possibly dozens and dozens of switches when their batteries run out and some contractors weren't certain that the residents would notice the battery issue if it wasn't for a device that was used often. One reply did acknowledge that piezoelectric wireless systems were a much better solution than battery-powered systems. Overall, the contractors did not seem to consider the possibilities of maintenance services as a relevant income source when they mostly dismissed any products that may require more maintenance than the traditional systems. Apparently the contractors felt that the maintenance would not require an electrical professional and thus would not concern their business.

7.2 BUILDING ELECTRICAL DESIGN AND CONTRACT

Majority of the replies confirmed that the home automation system was chosen by the client and the electrical designer, usually the initial idea of a certain system came from building fairs where clients visited and met device manufacturers' representatives. Electrical contractors felt that the system was necessary to decide from the early stage of designing, making designers the best people to inform clients of the systems. It was considered too late for contractors to start selling a system, as it would require complete redrawing of the electrical plan documents that usually are made before electrical contractor is selected. Contractors felt that the industry is so old fashioned that most of the professionals want to make only traditional electrical installations instead of complex automation systems.

When choosing a home automation system for a client, several different qualities are considered. Designers reflect which system is most convenient to design and still meets the client's criteria. Client has reasons for using automation, maybe it is to stay on top of technological development, getting the best possible house, preserving energy or having as easily maintainable house as possible: the reasons are various. Contractors will focus on issues like: whether they know the system, whether it is easy to install and program and whether they get their money from the client in the end. When designers choose the initial system, the contractors may or may not make an offer for the contract depending on whether they feel it is profitable for them. Contractors may not wish to learn a new system because it takes too much time and there is a bigger chance for errors and the extra costs will reduce their own contribution margin.

Often in building contracts the contractors have deals with different device manufacturers and electrical wholesalers and the bargaining influences also their decision to make an offer, as the price of the contract will depend on how much the equipment will cost, as the devices and components often have quite a distinctive coverage of 15-50% of the product price. That is one reason why different contractors often get different tender prices for a similar contract. Designers usually work on hourly wages and the price of the design work will depend on how many hours the designer can work on the project.

Thorough design plans will lead to savings in the contracting phase but still most clients seem to have saved in the worst possible place by commissioning the plans from the cheapest designer, leading into big troubles for the contractor who has to draw all the missing documents if only the minimum floor plan(s) are included. With a home automation system it is nearly impossible to know the aim of the designer if there isn't

comprehensive documentation, as the automation switches are not directly cabled to the devices they control and the switches can have many programmable functions instead of controlling for example a single light.

One issue with design plans according to contractors was that there were little knowledge on applicable realizations of home automation systems. There was no thorough understanding on the basic concepts of the home automation systems among most designers. Many interviewed contractors had received designs where an automation system that was originally meant for a full-house control (such as KNX or IHC) was only controlling a couple of light groups in a hallway or living room and leaving other parts of the house with traditional electrical system.

7.3 HOME AUTOMATION INSTALLATIONS

In order that electricians would be able to install the home automation systems there is a need of concrete and short instructions from the device manufacturers. There is a need for education of home automation systems and the differences of systems. There is also a need for programming training. The systems should be so easy to install that no specific knowledge is required from the installers.

7.4 CLIENT FEEDBACK AND PROJECT RESULTS

The most interesting result from the client's point of view came when interviewees were questioned about the client's needs for an automation system. The interviewees managed to come up with many reasons, such as ease of living, better control over the house, energy saving, comfort, increased security. Yet most of the interviewees felt that they were not suitable to market the positives to the client and that those reasons were not good enough to counterbalance the system's cost. The interviewees showed interest on getting more information about the clients' needs and it was unclear to some interviewees why clients wanted to use home automation in the first place.

Regarding the home automation system realizations, the major successes were lighting control applications and small programmable details, such as leakage sensor under the washing machine that causes a ceiling lamp start to blink when water is detected under the machine. Such details were also most difficult to implement as they require specific knowledge on the system's potential, but realizations like these create tangible proof to the home owner that the system is functioning properly.

7.5 HOME AUTOMATION CHALLENGES

Figure 28. Challenges in home automation systems.

The challenges of home automation were divided into seven categories: work tasks, technologies, education, attitudes, lack of marketing, system's high price and clients expectations (Figure 28).

The contractors work tasks multiply if the design documentation is not complete. The designers need more feedback on the project results and to gain knowledge on the quality of their work in reconstructive way. The traditional project delivery model, D-B-B, causes additional work in the tendering phase if the quantity calculations are made by each competing contractor instead of the information being provided by the designer. Contract pricing from inadequate tender documentation is difficult or impossible and the lack of proper documentation pushes the design responsibility to the contractor whom it doesn't belong. The alterations and corrections made in the constructing phase are very expensive and the client doesn't necessarily agree to pay for extra work after a total amount for the contract was negotiated in the design phase.

Some contractors felt that the initialization, maintain and support operations of the home automation systems caused them long-term obligations that would be difficult to get sufficient payment for. They didn't see the long-term commitment as an advantage whereas in other fields, such as mobile communications and internet providers, that is exactly where the companies want the client to engage as it brings money long after the product has been sold.

There were many competing technologies in the home automation field and the professionals needed more concrete information and instructions about the systems in

order to design, install and program the systems correctly. Especially information about integrating different electrical devices and systems under the automation system controlling was considered challenging.

Education was not felt to be sufficient for designing and installing the systems, and there has only recently been improvement for the Konnex system with KNX training offered at Tampere University of Applied Sciences (TAMK). Designers would benefit from practical information about home automation system installations to improve the accuracy of design documentation.

When searching for interviewees among electrical constructors, a very negative feedback was encountered. Some of the electrical contractors were not interested in including the automation systems in electrical constructing as they felt that the systems should be kept in a separate automation contract with specific contractors. However, the small construction scale of a detached house is challenging, as there is usually not enough capital to employ a different professional for each subcontract that an industry construction would be divided into.

It is difficult to find information on the possibilities of home automation systems and the marketing in the industry has been so minimal that the common knowledge of the topic is scarce. If the home building customers will not find enough information, the systems are not considered beneficial because of their usually high price. There lies a challenge for the device manufacturers: how to change the general idea of these systems being regarded as pricey extras for homes into a necessity that is needed regardless of the extra cost.

Some of the contractors were concerned about the prospective client's ability to pay the price of the home automation project and were reluctant and cautious to sell the systems unless the client showed strong interest in the technology and advantages instead of solely focusing on the price. Still the price is the competitive edge in electrical contracts so it is understandable that the clients always ask first about it.

The client's expectations were not known enough by the interviewees. They felt it was difficult to advertise the systems to the clients when they couldn't adequately state the benefits of the system from the client's point of view. Some of the interviewees also worried that the clients may have impossible requirements that weren't reasonable to realize and that the client would then be disappointed with the system.

Some of the contractors seemed to fear that it would only bring nuisance to accept what they conceive as a "complicated home automation systems": client would never be happy

with it and the constructor would have a great risk of losing capital when client would complain all the way to Consumer Disputes Board in and demand a reduction in price for a system that doesn't work how it should. Thus it was felt to be safer to work only with construction companies when dealing with smaller constructions than with the troublesome private customers.

Interestingly according to the interviews, there was a divided interception of client's knowledge of home automation systems. Some interviewees felt that the clients knew quite a lot about the systems whereas most felt that they did not know enough and had to be told about the systems. However, it seemed that the most experienced contractors felt that the clients did not know enough and the less experienced contractors felt that the clients were knowledgeable in the area.

7.6 HOME AUTOMATION CASE STUDIES

Some of the contractors had interesting examples on how the home automation projects are done today and what were the problem points. Even though the scope of the study is to take the electrical designer's and contractor's point of view, the following case examples were created from the interview material and are presented from the client's point of view. Ultimately it is the client who makes the decisions concerning their new home, even if they do not always have the information needed to make those decisions.

7.6.1 CASE 1: THIS IS THE BETTER SOLUTION

A client visits a home building fair where a home automation system is introduced. His interest wakes up as he gets brochures and talks to the sales representative in person. He decides to investigate the possibilities further at home. He searches from Internet about the system and decides that he wants the system to his home that he is about to build. He already has the house layout finished and it's time to start to look for designers and contractors to use. He contacts a few electrical designer companies whose information he has got from the system representative and from visiting their websites, and requests prices for electrical plans. After choosing the designer he then goes to an initial meeting to discuss the house's electrical systems. It is decided that the system will be used and the features are discussed with the designer according to what the client wants. He discovers totally new features that the house can have now that the system will be added. When the plans are ready, he sends them to several contractors for tenders. The designer company also makes a tender and the client decides it is the easiest way to use the same company for the entire system. The system is installed and configured according to the demands, and after the initialization of the system the contractor comes to adjust the system

features to the client's living habits after the family has settled. The same company from which the system was purchased also takes care of the client's training to use the system and any maintenance the system will need in future.

7.6.2 CASE 2: THIS IS THE USUAL STORY

A client visits a home building fair where a sales representative introduces an interesting home automation system. The client decides that he wants to use the system. He only gets a brochure but no further information. Internet website address was provided, but the page is very complicated and shows no information on professionals who can provide the system. The client contacts several electrical designers that he knows or has found from other Internet sites, such as www.mukavamminsahkolla.fi, and requests tenders from the designers. He then chooses the cheapest designer, saving at least a thousand Euros compared to the most expensive offer, and feels very happy that he bargained. The client is unaware that the simple floor plans he received are not even close to the documentation required to install a programmable automation system. When the floor plans are ready, he then sends them to electrical contractors for tenders. He has trouble in finding contractors who are ready to install automation systems, and when he requests prices for the contract, he only gets a few replies for the project. He is flabbergasted at the prices which are much higher than what the sales representative suggested, and feels offended as he's obviously been misled. Although it is very enticing to accept the two-three times cheaper offer for a traditional electrical system he got from a contractor he has acquaintance with, he finally settles on a contractor who was cheapest to implement the system. In the installation phase the troubles start to accumulate, the installations have problems and they do not work, the deadlines are passed and nothing gets finished. The contractor sends in big bills to cover additional expenses over the system and the client feels he's been totally shammed. But in the end, after considerably more expenses than in the first case, the system is finished and works roughly up to the client's expectations. Maybe he didn't get all the functions he wanted, like those situation controls and other fancier stuff, but he got the system he wanted and to think he could've paid a thousand Euros extra for the design!

7.6.3 THE DIFFERENCE

The two above mentioned cases do not seem to differ greatly from the electrical designer or contractor's point of view, but in reality there is a big difference. In the first example the designer knows to draw plans that are explicit and the contractor will have much easier time implementing the system. In the second case it is the client's responsibility to find suitable companies that are able to realize the system.

The second case could be a lot worse, the project may not even get completed as it had happened that some contractors had got requests to finish a home construction where previous contractor did not care to finish anymore after the client was not willing to pay more than was agreed on for the original work.

8 DISCUSSION

This chapter presents the correlation of study results compared to the theoretical background. The chapter offers recommendations on how to improve home automation situation in Finland and overcome the home automation challenges. Suggestions are expressed to improve the business models of the companies involved in the home automation field.

8.1 RELATIONS BETWEEN THEORY AND EMPIRICAL STUDY

The interviewed electrical designers and contractors mainly used one of the two building delivery types mentioned in the literary study: design-bid-build (D-B-B) was considered less successful system than design-build (D-B), which corresponds to the previous research.

Of the home automation systems, the star-topologied IHC/Elko Living system was often considered "old fashioned" system in comparison to the newer bus-based systems such as KNX. The answers were understandable concerning the star-topology being less popular as network topology in comparison to the newer and enhanced topologies, hierarchical, bus and mesh topologies.

Interviews confirmed the theoretical study concerning the KNX system's partial standardization issues as it was stated that there is a lack of standardization in the design and programming of the KNX systems. The KNX standard was not felt as open as it had been advertised for due to the expenses of membership and programming tool purchase fees.

The interviews showed prejudices towards wireless home automation systems and the theoretical facts from the device manufacturers were not sufficient for the interviewees to implement or recommend the wireless systems instead of the wired systems.

There seemed to be very mixed opinions about the improved energy savings through the use of automation systems, which reflected the conflicting results of the two German research studies concerning energy efficiency of KNX presented in Chapter 3.7. The interviewees shared the same reasons for the lack of energy savings, namely that the user's living style contributed to the energy savings the most and that the systems are often difficult to use to their best potential and that users easily operate the systems like traditional systems, seeking to adjust single devices instead of operating through user interface of the system.

8.2 FUTURE VIEWS

Today building automation is mundane and often crucial part in industrial constructions, for example in commercial centers, hospitals and airports. In the future home automation systems will become common in detached house constructing and other small scale buildings, if only the marketing reaches the customers and the industry professionals in a positive way.

There is a need for better productized home automation systems and a concept that can be replicated. Serial production would bring the product prices down to a more affordable level for the home owners. Also an introduction of simple entry level products that could be easily expanded would lower the threshold for the consumers. The whole industry of home automation systems needs a serious attempt to bring itself to the consumers' lives by for instance distributing free electronic gadgets that consumers could play within their house and that might inspire their imagination on what could be done with automation. Such products could be anything from single remote controlled LED-light to an infrared beam transmitter that triggers a remote alarm when trespassed or whatever that would give an inkling of the possibilities of automation. It is difficult to build a business case on shaky foundations, the technologies are ready but the market has not been prepared.

Today the more complex home automation systems such as KNX/EIB are cost-effective only in larger houses of well over 150m^2, as the smaller houses' building budget is often so tight that they can only afford the bare necessities. In coming years the ecology aspect is rising and the need to reduce energy consumption may increase the demand of these systems, especially now that the energy ratings of the home appliances are applied to the houses. The best case scenario for home automation system providers would be that without a certified automation system that monitors the energy consumption and CO_2 levels the best A-rating would not be awarded.

8.3 DEVELOPMENT RECOMMENDATIONS

The solutions to remedy the home automation challenges according to the interviews are:

1. Home automation systems should be sold as holistic projects to the client.
2. Increasing and improving marketing to consumers (especially at consumer fair venues and in TV programs such as interior or repair programs) and electrical designers.

3. Specific training for designers, contractors and electricians by device manufacturers, standard organizations and other stakeholders.

4. Specific, short and tangible instructions for each component from the device manufacturers. On the construction site long explanations with small font tend to get ignored.

5. Especially KNX systems require standardization of system design and programming.

6. Home automation systems should be included in energy certificates and energy ratings for houses or some other incentive to make the systems more attractive.

8.4 BUSINESS MODEL DEVELOPMENTS

The up and coming wireless technologies will present challenges for electrical contractors as most contractors are reluctant to let go of the traditional cabling in fear that their professionalism is not needed and anyone could install the wireless solutions. However, even the wireless solutions require electricians to install the transmitters and receivers and the decreased cabling will allow the electrical contractors a wider time frame to work on their project and give them more time to focus on the layout of the system and the details that matter most to the client. Even if most of the wireless systems function with battery power and may require battery changes, this will provide maintenance and service opportunities and enable the contractors to work in improving and maintaining the automation systems instead of only building the system from the components. Electrical contractors should regard their business as most of the security system providers do, they sell the whole package including equipment, installations, maintenance and security services, all wrapped up in a product that will let the client have ease of mind that their house is fully protected at all times without needing to employ several companies and personnel to reach that goal.

Instead of marketing individual services and systems at the fairs, the professionals and companies should form co-operation agreements and advertise the total package for the client: a home automation system from the first design meeting to the finished, fully functioning, product.

9 CONCLUSIONS

This chapter summarizes the most important results of the study and the improvements that should be made in future. The chapter presents topics for further research.

Today the electrical contractors have full responsibility of providing electrical systems but majority of them are not interested in investing to the home automation systems. There is a need to transfer the designing responsibility to the designers in order to improve the quality of electrical documentation. As the CAD tools have improved and include quantity calculation tools it is possible for designers to manufacture precise tender documentation. The improved documentation could equalize contractor competition when the tenders would have to be produced from similar component listings. The end result is reduction the system realization prices and the shift of designing responsibility to the designer.

In order of the home automation systems to become widespread in Finnish homes, there is a need to first educate the professionals and inform the customers about the systems. The home automation systems should be sold as projects instead of keeping the devices and the services separately. The systems must have precise and short instructions for installation and design that will help the realization of the system. The systems should be taken into consideration within the energy certification of houses or some other incentive should be given to the house owners that would encourage the implementation of the systems and the energy saving lifestyle.

The electrical designers and contractors would benefit from co-operation and device manufacturers could act as initiators by keeping track of professionals and informing the clients about the suitable companies.

9.1 RESULT EVALUATION AND SUGGESTIONS FOR FURTHER RESEARCH

This thesis was most successful at revealing the many challenges concerning the electrical designers, contractors and installers of home automation. Current work tasks of the home automation professionals were researched succesfully. Future improvements for home automation field and the businesses involved were identified from the interview results.

Research during this thesis was not able to identify new innovative killer applications that would improve the home automation system situation. Wireless systems may become such applications if the electrical professionals view of them will improve.

Designers and contractors showed interest in knowing the user's needs and requirements for the home automation systems and this area should be researched further.

Integration of different electrical systems in practice was one of the biggest problems with automation professionals. It is a key information in order of the home automation systems to become widespread.

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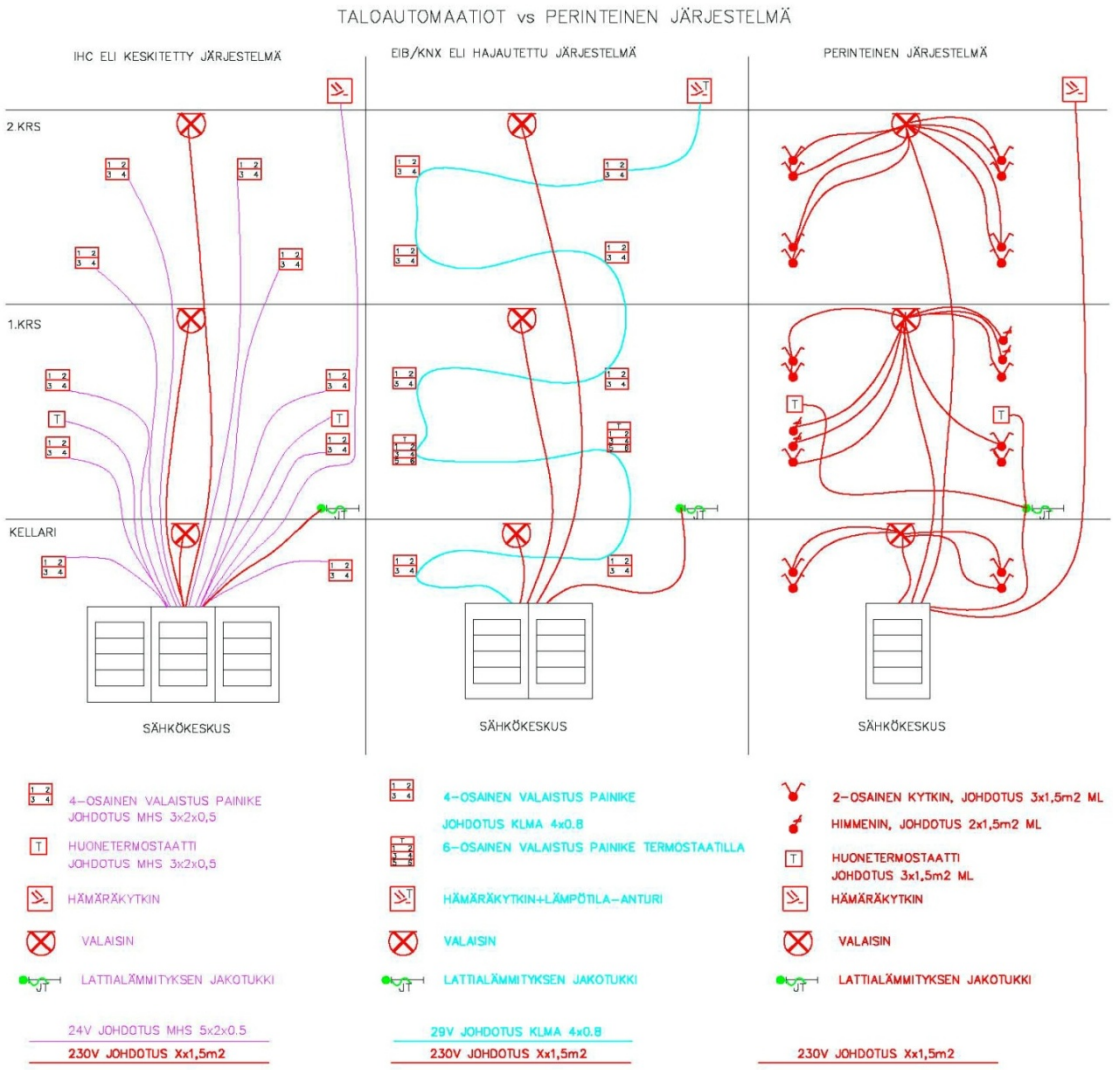
APPENDIX 1: HOME AUTOMATION SYSTEMS VS. TRADITIONAL HOUSE ELECTRICAL CIRCUIT DIAGRAM



Source: Ari Miettinen, Hendell Ltd, not published.

APPENDIX 2: INTERVIEW QUESTIONS

Taustatiedot

Nimi:

Yritys:

PVM:

Mikä on koulutustaustasi?

Mitä teet työksesi?

Laita ruksi ruutuun, mikäli et halua tietoja mainittavan opinnäytetyössä:

En halua nimeäni mainittavan diplomityössä ( )

En halua yritystäni mainittavan diplomityössä ( )

En halua koulutustaustaani mainittavan diplomityössä ( )

Kotiautomaatio

1) *Miten määrittelet kotiautomaation (rakennusautomaatio)?*
2) *Kuinka usein pientalorakennuskohteissa käytetään kotiautomaatiota? Millaisissa kohteissa?*
3) *Minkälaisia kotiautomaatiojärjestelmiä pientalohankkeissa käytetään? Laajuus, monimutkaisuus, valmistaja jne? Käytetäänkö yksittäisiä automatisoituja laitteita, kenttäväylä- vai jopa "älykoti"-tyyppisiä kokonaisratkaisuja?*
4) *Millä perusteella kotiautomaatiojärjestelmä valitaan tiettyyn kohteeseen? Tyyppi, laajuus, valmistaja, yms?*
5) *Kuka päättää millaista kotiautomaatiojärjestelmää käytetään pientalokohteissa?*
6) *Mitkä ovat yleisimmät kotiautomaatioon liittyvät standardit joita noudatetaan? (KNX/EIB, ZigBee, LON jne)*
7) *Mitä hyötyjä on kotiautomaatiojärjestelmästä verrattuna perinteisiin sähköasennuksiin ja –laitteisiin?*
8) *Minkälaisia käytännön eroja on langattomilla ja perinteisillä järjestelmillä? Langattomuuden hyödyt ja haitat?*
9) *Mikä on kotiautomaatiojärjestelmän käyttöaika?*

Suunnittelu

1) *Minkälaisia ovat tyypilliset suunnittelukohteenne, joissa käytetään kotiautomaatiota?*
2) *Kuinka tarkasti kotiautomaatiojärjestelmän tiedot määritetään suunnitteluvaiheessa?*
3) *Käytätkö yleensä jonkun tietyn valmistajan komponentteja/järjestelmiä suunnitelmissa? Miksi?*
4) *Tehdäänkö sähkösuunnitelmista myös massalaskenta? Kuinka tarkasti massat voidaan saada?*
5) *Kuinka haastavaa on yhdistää eri sähköjärjestelmät saman kotiautomaatiojärjestelmän alle?*
6) *Kuinka paljon suunnittelussa mietitään asukkaan asumismukavuutta ja henkilökohtaisia tarpeita? Vai keskitytäänkö vain saamaan asunnon perustoiminnot kuntoon?*
7) *Joutuuko sähkösuunnitelmia päivittämään myöhemmässä vaiheessa rakennusurakkaa?*
8) *Kuinka suuri lisäys tulee suunnittelukustannuksiin jos halutaan kotiautomaatiojärjestelmä? Kuinka suuri ero on pientalorakentamisessa verrattuna perinteiseen sähkösuunnitelmaan?*

Rakennusurakka

1) *Miten paljon pientalojen nykytekniikka eroaa esimerkiksi 80-luvun rakentamisesta? Onko eroja, miksi on/ei ole?*
2) *Mitä kuuluu tavalliseen pientalon sähköurakkaan?*
3) *Miten kotiautomaatio liitetään rakennusurakkaan? Asiakkaan pyynnöstä, aktiivisesti markkinoimalla tms? Miten urakoitsija voi vaikuttaa kotiautomaation valintaan?*
4) *Missä vaiheessa rakennusurakkaa kotiautomaatio otetaan huomioon?*
5) *Kuinka paljon rakennusurakassa mietitään asukkaan asumismukavuutta ja henkilökohtaisia tarpeita? Vai keskitytäänkö vain saamaan asunnon perustoiminnot kuntoon?*
6) *Kuinka suuri lisäys tulee rakennuskustannuksiin jos halutaan kotiautomaatiojärjestelmä? Entä elinkaarikustannuksiin?*
7) *Tuleeko pitkällä aikavälillä säästöjä?*

Asennus

1) *Kuka tekee kotiautomaatiojärjestelmän suunnittelun / ohjelmoinnin / asennuksen / koulutuksen / huollon?*
2) *Tarvitaanko kotiautomaation asennuksessa erityistä osaamista? Onko kaikilla asentajilla vaadittava tietotaito?*
3) *Onko (asentajan) koulutuksessa opetettu kotiautomaatiojärjestelmiä riittävästi?*

4) *Onko järjestetty lisäkoulutusta liittyen kotiautomaatioon? Oletteko itse osallistuneet lisäkoulutuksiin? Jos olette, niin mihin ja kuinka usein?*
5) *Onko kotiautomaatiojärjestelmissä yhteensopivuusongelmia? Missä järjestelmissä/asennuksissa erityisesti?*
6) *Mitkä ovat yleisimmät ongelmat kotiautomaation asennuksessa?*

Käyttäjä

1) *Tietävätkö kuluttajat kotiautomaatiojärjestelmistä? Entä uusimmista tuotteista?*
2) *Tietääkö asiakas etukäteen millaisen kotiautomaatiojärjestelmän hän haluaa?*
3) *Tietääkö asiakas etukäteen mitä ominaisuuksia kotiautomaatiojärjestelmässä tulisi olla?*
4) *Miksi asiakas haluaa käyttää kotiautomaatiota talossaan?*
5) *Mitkä kotiautomaatiotoiminnot ovat tärkeimmät/olennaisimmat asiakkaalle?*
6) *Onko helppo löytää asiakkaan tarpeisiin sopiva järjestelmä?*
7) *Kenen tulisi markkinoida kotiautomaatiojärjestelmistä asiakkaalle? Entä kuka mielestäsi tällä hetkellä tekee sen? Ehdotatteko itse kotiautomaatiojärjestelmää asiakkaalle, joka saattaisi olla kiinnostunut monipuolisemmasta talovarustelusta?*

Tulokset

1) *Miten hyvin kotiautomaatiojärjestelmien toteutus on onnistunut? Mikä toimii parhaiten?*
2) *Millaisia ongelmia asiakkailla on ollut kotiautomaatiojärjestelmien asennuksen, käyttöönoton tai käytön yhteydessä?*
3) *Miksi mielestäsi kotiautomaatio ei ole yleistynyt vuosien kuluessa?*
4) *Kuinka suuri osa asiakkaistanne asennuttaa kotiautomaatiojärjestelmiä pienrakentamisessa? Lukuina tai prosentteina: Omakotitalot, rivitalot, mökit?*
5) *Miten kotiautomaatiota voitaisiin tehdä tunnetummaksi?*
6) *Millaisia muutoksia näet rakentamisessa tulevaisuudessa?*

APPENDIX 3: QUESTIONNAIRE

Kyselylomakkeen vastauksia käytetään osana Teknillisen korkeakoulun diplomityötä ”Rakennusten digitalisointi – haaste sähköurakoitsijoille ja –asentajille”. Työssä selvitetään sähköurakoitsijoiden, -asentajien, -suunnittelijoiden ja laitevalmistajien kokemuksia kotiautomaatiosta. Yksittäisen henkilön vastauksia ei eritellä, vaan tiedot käsitellään yhtenä kokonaisuutena. Osallistujan nimi, koulutus ja yritys mainitaan opinnäytetyön liitteessä, jos vastaaja suostuu tähän. Mikäli osallistuja ei halua julkistaa nimeään, pyydämme silti täyttämään taustatiedot, jotta vastaukset voidaan hyödyntää tutkimuksessa.

Laita ruutuun ruksi, mikäli et halua tietoja mainittavan opinnäytetyössä

En halua nimeäni mainittavan diplomityössä	
En halua yritystäni mainittavan diplomityössä	
En halua koulutustaustaani mainittavan diplomityössä	

Taustatiedot

Nimi:

Yritys:

Aika ja paikka:

Koulutus:

Nykyinen työ:

Minulla on työkokemusta (kirjoita sopivin numero joka ruutuun):

5=yli 10 vuotta 4=4-10 vuotta 3=2-4 vuotta 2=alle 2 vuotta 1=ei yhtään

	Suunnittelu	Urakointi	Asennukset
Peruskotiautomaatiojärjestelmät (ECO-600, Ensto Smart)			
KNX/EIB/LON yms. väyläpohjaiset KA-järjestelmät			
”Älytalo” –ratkaisut			
Langattomat järjestelmät			

Kotiautomaatio (KA) pientalorakentamisessa

5=täysin samaa mieltä 4=jokseenkin samaa mieltä 3=en osaa sanoa 2=jokseenkin eri mieltä 1=täysin eri mieltä

	5	4	3	2	1
Pientalorakentamisessa tulisi mielestäni hyödyntää enemmän					

kotiautomaatiota					
Pientaloissa kotiautomaation hyödyt jäävät vähäisiksi niiden hintaan verrattuna					
Käytän vain tietyn valmistajan KA-järjestelmiä. (Mikä valmistaja? _____)					
KNX/EIB on suosituin kotiautomaatiojärjestelmä muutaman vuoden kuluttua					
Pientalojen KA-järjestelmät kehittyvät lähivuosina kohti ”älytaloa”					
Pientalojen KA-järjestelmät pysyvät yksinkertaisina ja releohjaukset riittävät					
Langattomat KA-järjestelmät ovat kokonaiskustannuksiltaan edullisempia kuin kiinteät					
KNX/EIB-väyläratkaisut ovat liian kalliita pientalorakentamiseen					
KNX/EIB-väyläratkaisut ovat liian monimutkaisia pientalorakentamiseen					
KNX/EIB-ratkaisut soveltuvat pientaloihin paremmin kuin yksinkertaiset KA-järjestelmät					
KA-järjestelmien käyttöikä on yli 10 vuotta					

Pientalon rakennusurakka

5=täysin samaa mieltä 4=jokseenkin samaa mieltä 3=en osaa sanoa 2=jokseenkin eri mieltä 1=täysin eri mieltä	5	4	3	2	1
Pientalojen nykytekniikka on hyvin samankaltaista kuin 80-luvulla					
Tyypillisesti asiakas teettää KA-järjestelmän sähkösuunnitelmat ennen urakkatarjousta					
KA-järjestelmän suunnittelu ja toteutus pientaloissa tulee sisällyttää sähköurakkaan					
KA-järjestelmän suunnittelu ja toteutus pientaloissa tulee pitää erillisurakkana					
KA-järjestelmät on yleensä esitetty riittävän yksityiskohtaisesti sähkösuunnitelmissa					
KA-järjestelmän sisältävän sähkösuunnitelman perusteella on yleensä helppo tehdä pitävä urakkatarjous					

KA-järjestelmän sisällyttäminen sähköurakkaan aiheuttaa usein yllättäviä lisäkustannuksia rakennusvaiheessa					
KA-järjestelmän sisällyttäminen sähköurakkaan vaatii suuremman katteen urakkahintaan kuin muut sähköjärjestelmät, jotta yllättäviä lisäkuluja voidaan ennakoida					
Kaikkien pientalo-sähköurakoitsijoiden tulisi tehdä myös KA-urakointia					
Vain sertifioitujen/lisensoitujen sähköurakoitsijoiden tulisi tehdä myös KA-urakointia					

Kotiautomaatiojärjestelmän asennus

5=täysin samaa mieltä 4=jokseenkin samaa mieltä 3=en osaa sanoa 2=jokseenkin eri mieltä 1=täysin eri mieltä	5	4	3	2	1
KA-järjestelmän asennus vaatii erityisosaamista jota ei löydy joka sähköasentajalta					
On helppo löytää asentajia, jotka osaavat tehdä KA-järjestelmäasennuksia					
KA-järjestelmien asennusta ei opi koulussa vaan työssä tekemällä					
KA-järjestelmien asennuksesta tarvittaisiin lisäkoulutusta					
KA-järjestelmien asennuksesta tarvittaisiin selkeämpiä ohjeita laitevalmistajilta/maahantuojilta					
Kotiautomaatiojärjestelmien asennusta vaikeuttavat yhteensopivuusongelmat					
Eri sähköjärjestelmien yhteensovittaminen KA-järjestelmällä on vaikeaa (esim. lämmitys, ilmastointi, valaistus, äänentoisto, viihde-elektroniikka, tietotekniikka)					
KA-järjestelmän käyttöönottoon liittyvä ohjelmointi ei ole vaikeaa					
KA-järjestelmän ohjelmointia varten tarvitaan konsultti tai muu ulkopuolinen asiantuntija					
Käyttämissäni KA-järjestelmissä ei tarvita ohjelmointia					
KA-järjestelmää on helppo päivittää tulevien tarpeiden mukaan					

Käyttäjät

5=täysin samaa mieltä 4=jokseenkin samaa mieltä 3=en osaa sanoa 2=jokseenkin eri mieltä 1=täysin eri mieltä	5	4	3	2	1
Yksityisasiakkaat osaavat kysellä KA-järjestelmistä jo tilausvaiheessa					
On helppo löytää yksityisasiakkaan tarpeisiin sopiva KA-järjestelmä					
Yksityisasiakkaan on vaikea selvittää, millaisen KA-järjestelmän hän haluaa					
KA-järjestelmän suunnittelu perustuu asiakkaan tarpeisiin					
Yksityisasiakas voi itse valita KA-järjestelmän valmistajan ja laitteiston					
Suosittelen yleensä asiakkaalle tiettyä KA-järjestelmää, joka sopii käyttötarkoitukseen					
Suosittelen yksityisasiakkaalle yleensä yksinkertaisinta KA-järjestelmää					
Suosittelen yksityisasiakkaalle yleensä kattavinta KA-järjestelmää					
Suosittelen yksityisasiakasta käyttämään perinteistä sähköistystä					
Asennettu KA-järjestelmä on lähes aina toiminut asiakkaan haluamalla tavalla					

Tulokset

5=täysin samaa mieltä 4=jokseenkin samaa mieltä 3=en osaa sanoa 2=jokseenkin eri mieltä 1=täysin eri mieltä	5	4	3	2	1
KA-järjestelmät tulevat yleistymään lähivuosina selvästi					
KA-järjestelmän asennus on sujunut ongelmitta					
KA-järjestelmissä on usein ilmennyt vikoja/ongelmia käyttöönoton jälkeen					
KA-järjestelmät vaativat paljon huolto- ja ylläpitotoimia asennuksen jälkeen					
KA-järjestelmien käytettävyyttä tulisi parantaa jotta ne yleistyisivät					
KA-järjestelmien yleistyminen on kiinni tuotteiden markkinoinnista kuluttajille					
KA-järjestelmien yleistyminen on kiinni urakoitsijoiden kiinnostuksesta markkinoida niitä asiakkailleen					
Urakoitsijat eivät vaikuta KA-järjestelmien yleistymiseen					

KA-järjestelmällä voidaan aikaansaada selviä säästöjä asumiskustannuksiin					
KA-järjestelmällä voidaan aikaansaada selviä säästöjä energiankulutukseen					
KA-järjestelmä parantaa pientalon myyntiarvoa					
KA-järjestelmän tekniikka vanhenee liian nopeasti					

Kiitos osallistumisesta!

APPENDIX 4: INTERVIEW RESULTS

Haastatteluun osallistuneita: 9kpl
Sähkösuunnittelijat (S): 2kpl, haastateltavat 4, 5
Sähköurakoitsijat (U): 2kpl, haastateltavat 3, 6
Molemmat (S/U): 5kpl, haastateltavat 1, 2, 7, 8, 9

Alkuperäiset vastaukset ovat laajempia ja ne on pyritty esittämään tässä liitteessä lyhyesti.

1. *KOTIAUTOMAATIO*

1) *Miten määrittelet kotiautomaation (rakennusautomaatio)?*
   (=Mitä sisältyy kotiautomaation määritelmään)
   8 vastausta
   valaistuksen ohjaus kuuluu kotiautomaatioon 3 (U), 4 (S), 6 (U), 8 (S/U)
   LVIS-ohjaus kuuluu kotiautomaatioon 1 (S/U), 6 (U), 7 (S/U)
   järjestelmän tulee olla yhtenäinen 1 (S/U), 3 (U), 5 (S), 6 (U)
   yksittäiset automaatiolaitteetkin ovat kotiautomaatiota 7 (S/U)

2) *Kuinka usein pientalorakennuskohteissanne käytetään kotiautomaatiota?*
   9 vastausta
   1-2 kohdetta vuodessa 3 (U), 4 (S), 5 (S), 6 (U), 8 (S/U), 9 (S/U)
   selvä enemmistökohteista 1 (S/U), 2 (S/U)
   vielä ei ole ollut yhtään kohdetta 7 (S/U)

3) *Minkälaisia kotiautomaatiojärjestelmiä pientalohankkeissa käytetään? Laajuus, monimutkaisuus, valmistaja jne? Käytetäänkö yksittäisiä automatisoituja laitteita, kenttäväylä- vai jopa "älykoti"-tyyppisiä kokonaisratkaisuja?*
   9 vastausta
   kenttäväylä 1 (S/U), 2 (S/U), 3 (U), 4 (S), 5 (S)
   KNX/EIB 2 (S/U), 4 (S), 5 (S), 6 (U), 8 (S/U), 9 (S/U)
   IHC/Elko LS 3 (U), 4 (S), 5 (S), 8 (S/U)
   ei mitään 7 (S/U)

4) *Millä perusteella kotiautomaatiojärjestelmä valitaan tiettyyn kohteeseen? Tyyppi, laajuus, valmistaja, yms?*
   9 vastausta
   suunnittelijan kautta 3 (U), 4 (S), 6 (U), 7 (S/U), 8 (S/U), 9 (S/U)
   tilaaja kysyy 3 (U), 4 (S), 5 (S), 8 (S/U), 9 (S/U)
   toteuttamisen helppous 2 (S/U), 3 (U), 5 (S)
   hinta 1 (S/U)
   valmistaja 2 (S/U), 3 (U), 5 (S)

5) *Kuka päättää millaista kotiautomaatiojärjestelmää käytetään pientalokohteeissa?*
   6 vastausta
   asiakas 3 (U), 5 (S), 7 (S/U), 9 (S/U)
   suunnittelija 3 (U), 4 (S), 6 (U), 9 (S/U)
   urakoitsija 6 (U), 7 (S/U)
   pääsuunnittelija 7 (S/U)

6) *Mitkä ovat yleisimmät kotiautomaatioon liittyvät standardit joita hyödynnetään kohteissa? (KNX/EIB, ZigBee, LON jne)*
   7 vastausta
   KNX 1 (S/U), 2 (S/U), 5 (S), 9 (S/U)

EIB 4 (S), 6 (U)
IHC 1 (S/U), 6 (U)
X10 (ei käytetty, mutta yhdeltä on sitä kysytty 1 (S/U) ja yhden kerran se mainittiin haastattelussa 3 (U))
LON (ei käytetty mutta mainittiin haastatteluissa 1 (S/U), 2 (S/U))

7) *Mitä hyötyjä on kotiautomaatiojärjestelmästä verrattuna perinteisiin sähköasennuksiin ja –laitteisiin?*
9 vastausta
muunneltavuus 1 (S/U), 4 (S), 9 (S/U)
monipuolisuus 3 (U), 5 (S), 8 (S/U)
keskitetty ohjaus 4 (S)
mukavuus 2 (S/U), 5 (S), 6 (U), 8 (S/U), 9 (S/U)
energiansäästö 6 (U), 7 (S/U)
turvallisuus 9 (S/U)
laajennettavuus 9 (S/U)

8) *Minkälaisia käytännön eroja on langattomilla ja perinteisillä järjestelmillä? Langattomuuden hyödyt ja haitat?*
9 vastausta
+vähemmän johdon vetoa 1 (S/U)
+sopii rakennusteknisesti hankaliin paikkoihin 3 (U)
+saneerauskohteisiin 4 (S), 6 (U), 7 (S/U), 9 (S/U)
+säästää aikaa / rahaa 3 (U)
+lähinnä sopii valojen ohjaukseen 3 (U)
+monipuolistaa huoneiden kalustusta 3 (U)
+pietsosähköllä toimivat ok 9 (S/U)
-paristot (vaihto, tarkistus) 1 (S/U), 6 (U), 8 (S/U), 9 (S/U)
-ei voi puhua automaatiosta 2 (S/U)
-hinta (yhtä kallis kuin EIB isoissa kohteissa) 4 (S), 7 (S/U)
-suunnittelussa ei hirveästi eroja 5 (S)
-kiinteät varmempia ratkaisuja 6 (U)
-tarvikemyyntiä tulee enemmän kiinteillä, ei kannata käyttää langattomia 9 (S/U)

9) *Mikä on kotiautomaatiojärjestelmän käyttöaika?*
8 vastausta
+useita kymmeniä vuosia, 30v, 25v, 20-30v 1 (S/U), 5 (S), 6 (U), 7 (S/U)
+ensimmäinen asennettiin 1994, ei ongelmia tähän mennessä 3 (U)
-ei olla täällä vielä käytetty riittävän pitkään kodeissa että osaisi sanoa 2 (S/U)
-varaosien saatavuus ja ohjelmien muuttuminen rajoittaa käyttöikää 1 (S/U)
-en tiedä 4 (S), 9 (S/U)

2. *SUUNNITTELU*

1) *Minkälaisia ovat tyypilliset suunnittelukohteenne, joissa käytetään kotiautomaatiota?*
4 vastausta
parempia/isompia omakotitaloja 3 (U), 4 (S), 5 (S), 8 (S/U)

2) *Kuinka tarkasti kotiautomaatiojärjestelmän tiedot määritetään suunnitteluvaiheessa?*
8 vastausta
-suunnittelu ei ole kovin pätevää 2 (S/U), 3 (U), 9 (S/U)
-vedetään vanhalla tyylillä 2 (S/U)

+tehdään mahdollisimman tarkkaan 4 (S), 5 (S), 6 (U), 8 (S/U), 9 (S/U)
+suunnitteluun kuuluu työselostus, sähköpistekuvat, ryhmityskuvat, keskuskaaviot, eri järjestelmistä omat kaaviot (antenni-, yleiskaapelointi-, rikosilmoitus- ja palovaroitinkaaviot), valaisinluettelot ja jos on lvi-tiedot saatavilla niin lvi-luettelo ja jos siellä tulee jotain sähköön liittyvää niin niistä kaaviot. 4 (S)
+2/3 asiallisia, 1/3 huonoja 6 (U)
-ei ole alkuvaiheessa laite/tyyppikohtaisesti tiedossa, asiakaskaan ei vielä tiedä mitä tulee 7 (S/U)

3) *Käytätkö yleensä jonkun tietyn valmistajan komponentteja/järjestelmiä suunnitelmissa? Miksi?*
5 vastausta
-Ensto EIB/Busch-Jaeger 4 (S), 7 (S/U), 8 (S/U), 9 (S/U)
-Berker 2 (S/U), 8 (S/U)
-IHC 4 (S)
-asiakas päättää 5 (S)

4) *Tehdäänkö sähkösuunnitelmista myös massalaskenta? Kuinka tarkasti massat voidaan saada?*
7 vastausta
tehdään 6 (U), 9 (S/U)
-ei tehdä 3 (U), 4 (S), 5 (S), 7 (S/U), 8 (S/U)
-asiakkaan täytyy erikseen tilata ne 5 (S), 8 (S/U)
-pysytään vanhassa kaavassa 5 (S)
-ei ole ohjelmaa 7 (S/U)
-saa ohjelmasta suoraan 5 (S), 8 (S/U), 9 (S/U)
-on sama kuka sen tekee 5 (S)
-suunnittelijan pitäisi tehdä 2 (S/U), 3 (U), 6 (U), 9 (S/U)
-urakoitsija tekee 4 (S), 6 (U), 8 (S/U)

5) *Kuinka haastavaa on yhdistää eri sähköjärjestelmät saman kotiautomaatiojärjestelmän alle?*
8 vastausta
-tarvitaan koulutusta 2 (S/U)
-vaatisi ajattelua ja suunnittelua, tilaohjaukset yms. jää usein pois 3 (U)
-täytyy ottaa huomioon jo suunnitteluvaiheessa, ei vasta ohjelmoinnissa 8 (S/U), 9 (S/U)
-käytännössä toteutetaan ohjelmointipuolella 9 (S/U)
-laitteet pitää valita sen mukaan millainen automaatiojärjestelmä 8 (S/U)
-vähän haastavaa mutta ei ongelma 4 (S)
-järjestelmä voi tulla liian monimutkaiseksi asiakkaalle jos yhdistetään toimintoja 9 (S/U)
-suunnittelu ei ole sillä tasolla että toimisi 6 (U)
-iv-suunnittelijan pitäisi voida ottaa huomioon automaatiojärjestelmä 6 (U)
-sähkö- ja iv-suunnittelijan pitäisi tehdä yhteistyötä 6 (U), 8 (S/U)
-ohjelmointi on suurin haaste 5 (S)

Lisäkysymys: Kuka tekee loppukuvat
5 vastausta
urakoitsijan vastuulla 3 (U), 4 (S), 6 (U), 8 (S/U), 9 (S/U)
suunnittelijan osuus päättyy melkein urakkalaskentakuviin 3 (U), 6 (U), 9 (S/U)
suunnittelijan ei pitäisi tehdä niitä koska ei ole paikalla rakennusvaiheessa 9 (S/U)

suunnittelija voisi tehdä mekaanisen piirtämisen 9 (S/U)
suunnittelija voisi tehdä loppukuvat 3 (U), 6 (U), 8 (S/U)
suunnittelija oppisi paremmin tekemään järjestelmiä jos tekisi loppukuvat 8 (S/U), 9 (S/U)

6) *Kuinka paljon suunnittelussa mietitään asukkaan asumismukavuutta ja henkilökohtaisia tarpeita? Vai keskitytäänkö vain saamaan asunnon perustoiminnot kuntoon?*
4 vastausta
asumismukavuus on kaiken lähtökohta 9 (S/U)
asiakkaalla on selvä näkemys mitä hän haluaa 5 (S)
asiakkaan kanssa neuvotellaan yhteistyössä 4 (S), 8 (S/U)

7) *Joutuuko sähkösuunnitelmia päivittämään myöhemmässä vaiheessa rakennusurakkaa?*
8 vastausta
-tulee paljon muutoksia 2 (S/U)
-huonot suunnitelmat aiheuttaa lisätyötä 3 (U)
-automaation kanssa suurempi riski että tulee ongelmia 3 (U)
-ei tietoa koska suunnittelija ei osallistu 4 (S), 8 (S/U)
+perusomakotitaloissa harvoin tulee muutoksia 3 (U)
+yleensä pieniä muutoksia 5 (S), 6 (U), 7 (S/U), 9 (S/U)

8) *Kuinka suuri lisäys tulee suunnittelukustannuksiin jos halutaan kotiautomaatiojärjestelmä? Kuinka suuri ero on pientalorakentamisessa verrattuna perinteiseen sähkösuunnitelmaan?*
4 vastausta
-ei suurta muutosta 4 (S)
-voi olla huomattava 30-50% 5 (S)
-10-20% (joku sata euroa) 2x 4 (S), 8 (S/U)
-kolminkertainen 9 (S/U)
-perussuunnittelu ~1000e automaatio ~1500-2000e 5 (S), 8 (S/U)

3. RAKENNUSURAKKA

1) *Miten paljon pientalojen nykytekniikka eroaa esimerkiksi 80-luvun rakentamisesta? Onko eroja, miksi on/ei ole?*
8 vastausta
-kiire 1 (S/U)
-pääosin pysynyt samana 3 (U), 4 (S), 6 (U), 8 (S/U), 9 (S/U)
-konservatiivista 3 (U)
-tehdään halvalla 3 (U)
-enimmäkseen tehdään yhä perus-sähköjärjestelmiä 4 (S), 5 (S)
+sähkölaitteita/kulutuspisteitä on enemmän 3 (U), 5 (S), 6 (U), 7 (S/U)
+yleiskaapelointi 3 (U), 4 (S), 6 (U), 7 (S/U)
+asiakkaiden vaatimustaso kasvanut 1 (S/U)
+käytetään enemmän rahaa 1 (S/U)
+valaistukseen kiinnitetään enemmän huomiota 3 (U), 4 (S), 7 (S/U)
+langaton tiedonsiirtoverkko 7 (S/U)
+automaatiojärjestelmät on lisääntyneet 5 (S), 8 (S/U)
+turvallisuusasiat on tulleet esiin 9 (S/U)

2) *Mitä kuuluu tavalliseen pientalon sähköurakkaan?*
7 vastausta.

-sähkökalusteet, asennusvalaisimet sekä lisäksi usein antenni/data ja melko usein turvajärjestelmä 1 (S/U)
-sähkötyöselityksen mukainen toimitus avaimet käteen. Sähköurakoitsija vetää kaapelit myös erikoisurakan laitteille jos urakka on pilkottu, esim. turvapalvelut voidaan jättää pois sähköurakasta. Jos joutuu kuvista laskemaan urakkahintaa ja kuvat on huonot niin se on mahdotonta ja tulee paljon lisähintaa. Sähköurakoitsija vastaa koko sähköurakasta. On hyvä jos urakoitsija osaa ohjelmoida, mutta ei välttämätöntä kunhan ymmärtää järjestelmän päälle ja huomaa virheet eikä luota sokeasti kuviin. Keskus pitäisi aina teettää keskusvalmistajalla. 2 (S/U)
-kaikki mikä liittyy sähköön. Suunnitelmien perusteella massoitellaan ja lasketaan urakkahinta. 3 (U)
-sähkötyöt, automaatiojärjestelmät, turvajärjestelmät. Urakoitsija vastaa siitä, että talo vastaa piirrustuksia. 6 (U)
-piha-/tonttikeskuksesta taloon päin kaikki asennustyöt, sähkötarvikkeiden, pistorasioiden, katkaisijoiden hankinta, antennijärjestelmien asennus, yleiskaapelointi, ihan täyteen käyttökuntoon ja käyttötarkistus. 7 (S/U)
-koko paketti mikä vähänkään liittyy sähköön. Alkaa perustusten maadoituksella, kaapeloinnit, keskusten asennukset, keskusten piirikaavioiden teko on usein urakoitsijalla, mikä olisi hyvä että suunnittelija tekisi. Taloautomaatiokohteissa tilataan keskukset. 7 (S/U)
-Asiakkaan ajatusten mukaisesti kaikki. Eritellään valaisimet erikseen, sillä ne usein muuttuu rakennusprojektin aikana. Suunnitelmissa on määritelty mitä kuuluu sähköurakkaan. 9 (S/U)

3) *Miten kotiautomaatio liitetään rakennusurakkaan? Asiakkaan pyynnöstä, aktiivisesti markkinoimalla tms? Miten urakoitsija voi vaikuttaa kotiautomaation valintaan?*
6 vastausta
+asiakkaat kyselee messujen/mainosten kautta 1 (S/U)
+sähköurakoitsija voi valintaan myötävaikuttaa tai torpedoida idean 1 (S/U)
+pitää ottaa huomioon heti alussa / suunnitteluvaiheessa 5 (S), 6 (U), 9 (S/U)
-vaikea perustella asiakkaalle miksi kannattaa ottaa koska hinta on korkea 3 (U)
-asiakas ei näe hyötyjä etenkin jos kyseessä perusomakotitalo 3 (U)
-hintaa voisi perustella energiansäästöllä, otetaan talon laitteistosta kaikki hyöty irti ja säästetään siellä missä voidaan, ja sillä että kaikki järjestelmät tulisi hoidettua samassa paketissa 7 (S/U)

4) *Missä vaiheessa rakennusurakkaa kotiautomaatio otetaan huomioon?*
6 vastausta
suunnittelun alkuvaiheessa 1 (S/U), 2 (S/U), 4 (S), 6 (U), 7 (S/U), 9 (S/U)

5) *Kuinka paljon rakennusurakassa mietitään asukkaan asumismukavuutta ja henkilökohtaisia tarpeita? Vai keskitytäänkö vain saamaan asunnon perustoiminnot kuntoon?*
3 vastausta
alussa mietitään mukavuutta, lopussa on kiire saada perustoiminnot kuntoon 1 (S/U)
tärkein asia on parantaa mukavuutta 2 (S/U), 9 (S/U)
yleensä urakoitsijat mielellään käyttää perinteisiä järjestelmiä kun näitä käytetään niin vähän 3 (U)

6) *Kuinka suuri lisäys tulee rakennuskustannuksiin jos halutaan kotiautomaatiojärjestelmä? Entä elinkaarikustannuksiin ?*
7 vastausta

-koko kustannuksista isot kohteet 2-5%, pienissä vähän enemmän 5-7% 1 (S/U)
-esim. 300m2 talo perinteinen su 40t, IHC 60t, KNX 54t 2 (S/U)
-30% tulee IHC järjestelmään 3 (U)
-normaali su 30t, tulee n.10t lisää 6 (U)
-ainoa mikä maksaa asiakkaalle on se järjestelmä ja mitä siihen laitetaan. Jonkin verran voi tulla lisätyötä, ehkä 5% lisää hintaa (vastaaja ei ole tehnyt automaatiojärjestelmiä) 7 (S/U)
-varmaan se 15t on aika lähellä KNX:llä. Berkerin edustajan mukaan n. 45e/m2 mutta se on aika alhainen hinta. Kyllähän se harjoittelu aina maksaa enemmän… Dali maksaa +1000e. 8 (S/U)
-3x, perinteinen su 15-25t (200m2) 9 (S/U)

7) *Tuleeko pitkällä aikavälillä säästöjä?*
9 vastausta
- tarvitaan liian pitkä käyttöaika että tulisi säästöä 1 (S/U)
-en usko että maksaa takaisin 3 (U)
-ei järjestelmä nosta myyntiarvoa 3 (U)
-sähköpuolella ei voida paljoa vaikuttaa 4 (S)
-halvimmat laitteet ei sitten toimi jos halutaan optimoida 2 (S/U)
-säästö on käyttäjästä kiinni 1 (S/U), 2 (S/U), 6 (U)
-aika marginaalisesti voidaan saada säästöjä 8 (S/U)
-pelkällä valaistuksen säädöllä ei saada säästöä 9 (S/U)
+valaistusta voidaan säästää 2 (S/U), 6 (U), 8 (S/U)
+väylätekniikka vähentää kaapelointia 5 (S)
+ohjelmoinnilla saadaan valaistusta ja muuta sähkönkulutusta pienemmäksi 5 (S)
+ekologisesti säästö maksaa itsensä takaisin nopeasti, taloudellisesti ei 5 (S)
+pitkällä aikavälillä voidaan saada säästöjä, jos yhdistetään lämmitys, iv ja valaistus 6 (U)
+lämmityksen ohjauksella voidaan saada säästöä 4 (S), 6 (U), 7 (S/U), 9 (S/U)

4. ASENNUS

1) *Kuka tekee kotiautomaatiojärjestelmän suunnittelun / ohjelmoinnin / asennuksen / koulutuksen / huollon?*
9 vastausta
-sama firma hoitaa koko homman alusta loppuun 1 (S/U)
-suunnittelija suunnittelee toimivan kokonaisuuden ja laatii massalistat, urakoitsija laskee urakan niillä määreillä 2 (S/U)
-ollaan tehty ohjelmointia, mutta nykyään Selega tekee keskukset suunnitelman mukaan ohjelmoituna, niin ei tehty viimeiseen kohteeseen. Huolto/päivitys/opetus ollaan tehty jotain pieniä muutoksia sen jälkeen kun talo on valmistunut (sen jälkeen ne on jäänyt). Huoltopuolella olisi varmaan kysyntää. 3 (U)
-tehdään vain suunnittelua 4 (S)
-ei toteuteta ohjelmointia, se on urakoitsijan vastuulla. Urakoitsija tuo keskukset. 5 (S)
-suunnittelu tulee asiakkaan kautta. Asennus, ohjelmointi ja koulutus tehdään itse. Huoltokin kuuluu palveluun. 6 (U)
-tehdään suunnittelu+urakointi+asennus ja myös huoltoa. 7 (S/U)
-ohjelmointi on urakoitsijan vastuulla, olen ostanut ohjelmointi/koulutuspalvelut toiselta. Tarkoitus olisi opetella itse, mutta se vaatii niin paljon aikaa opetella. 8 (S/U)
-mielellään tehdään suunnittelu koska osa suunnitelmista on niin vajaavaisia. Tehdään ohjelmointi, huolto, asennus, koulutus. Pystytään päivittämään järjestelmä uudelle asukkaalle. 9 (S/U)

2) *Tarvitaanko kotiautomaation asennuksessa erityistä osaamista? Onko kaikilla asentajilla vaadittava tietotaito?*
8 vastausta
-nykyiset järjestelmät on niin helppoja ja niissä on hyvät ohjeet, että erikoiskursseja ei tarvitse, riittää että on "näpertelytaitoa" pienten johtojen kanssa 1 (S/U)
-kaikilla ei ole vaadittavaa taitoa. Järjestelmiä on erilaisia joten vaaditaan kokonaiskuva aiheesta. Laitevalmistajilla/maahantuojilla pitäisi olla riittävän hyvät ohjeet, jolloin asentajilta ei tarvittaisi erityistaitoja. 2 (S/U)
-kyllä löytyy tietotaitoa, uuden opettelu vain vaatii aikaa. Ohjeita löytyy aika hyvin ainakin netistä. 3 (U)
-kyllä pystyy toteuttamaan, ei se niin vaikeaa ole 5 (S)
-vanhemmilla asentajilla ei ainakaan ole riittävästi tietoa. Siihen aikaan kun opiskelin ei ollut mitään automaatiota. 6 (U)
-jos on asentajan koulutus niin pitää pystyä tekemään. Niissä laitteissa ei saa olla mitään niin vaikeaa ettei sähköasentaja pystyisi niitä tekemään. Uskon että valmistajilta saa riittävät ohjeet. 7 (S/U)
-kyllä pitäisi kuvien perusteella onnistua 8 (S/U), 9 (S/U)
-Kyllä periaatteessa koulutettu sähköasentaja osaa asentaa, mutta ohjelmointia ei. 9 (S/U)
-maahantuoja tai valmistaja voisi antaa sertifikaatin niille suunnittelijoille jotka tekevät hyvät suunnitelmat. 9 (S/U)
-sertifiointi olisi hyvä, mutta kohteiden vähyys tekee sen ettei se ole mahdollista. 3 (U)

3) *Onko (asentajan) koulutuksessa opetettu kotiautomaatiojärjestelmiä riittävästi?*
6 vastausta
+monet koulut ovat tähän kiinnittäneet huomiota, joten ei pitäisi olla koulutuksesta kiinni 1 (S/U)
+on ollut riittävästi sähköinsinöörikoulutuksessa, järjestelmät on esitelty ainakin pintapuolisesti. Tärkeintä on tietää järjestelmän pääasiat ja tuntea sen toiminta-ajatus. Käytännössä oppii vasta töissä. 5 (S)
-ei, toivottavasti tulevaisuudessa on parempaa koulutusta 2 (S/U)
-(asentajan) koulutukseen ei panosteta yhtään, asennuspuolella ei saisi erikoistua liian nopeasti, esim. automaatiokoulu tai vahvavirtapuoli. 3 (U)
-Helsingissä ei tainnut olla mitään aiheesta, paitsi valaistuksen ohjauksesta (DALI) ja minilogiikasta, mutta ei pientalon kannalta. 8 (S/U)
-koulutus on se vajaavaisuus, urakoitsijat on koulutettu mutta tuskin suunnittelijat on käyneet 9 (S/U)

4) *Onko järjestetty lisäkoulutusta liittyen kotiautomaatioon? Oletteko itse osallistuneet lisäkoulutuksiin? Jos olette, niin mihin ja kuinka usein?*
8 vastausta
-Laitevalmistajilla on hyviä kursseja 1 (S/U)
-KNX koulutus tulossa, maahantuojilta ja laitevalmistajilta saa lisäkoulutusta 2 (S/U)
-isoista järjestelmistä (TAC ja Computec) on ollut ja IHC:sta. Uskon että joka järjestelmästä saa perustason koulutusta. Laitevalmistajat järjestää lisäkoulutusta. Koko ajan täytyy käydä kursseilla että pysyy ajan tasalla. 3 (U)
-En ole käynyt, työn kautta on oppinut. On laite-esittelyjä, mutta niihin tarvitsee mennä. Eniten on valaisinesittelyjä, aika vähän on näistä järjestelmistä mitään. Laitevalmistajilla on omia koulutustilaisuuksia, mutta työtilanteiden takia en ole pystynyt osallistumaan. Jos on joku uusi oikeasti mielenkiintoinen tuote, niin voisi

lähteäkin. KNX-koulutuksen tyyppiset tilaisuudet on varmasti hyviä. Jos koulutus on hyödyllinen niin se yleensä myös maksaa. 5 (S)
-Kauan sitten osallistuin johonkin laitekoulutukseen, mutta muuten olen opetellut itse tai kysynyt laitevalmistajilta. 6 (U)
-en ole ehtinyt vielä laitevalmistajien koulutuksiin. Koulutuspäiviin olen osallistunut (Fortum, sähköturvallisuus tms), automaatiokoulutukseen en ole osallistunut. Alan lehdistä saa paljon tietoa. 7 (S/U)
-KNX-seminaarissa olin, ja aikoinaan IHC-koulutuksessa. Laitetoimittajat on järjestänyt jotain pienimuotoista koulutusta, mutta ei ne ole olleet kauhean hyödyllisiä. Itse olen opetellut omalla ajalla, kyllä se on vaivan maksanut takaisin vaikka ei hirveästi ole näitä tehty vielä. 8 (S/U)
-Laitevalmistajan koulutuksessa olen käynyt kerran, kun ei ole mitään koulutusta. KNX:stä tarvitsisi paljon lisää koulutusta. 9 (S/U)

5) *Onko kotiautomaatiojärjestelmissä yhteensopivuusongelmia? Missä järjestelmissä/asennuksissa erityisesti?*
8 vastausta
-mm. järjestelmän ja iv-koneen yhdistämisessä, monet maalämpöpumput hankalia. Tarvitaan monta gsm-liittymää eri laitteita varten. 1 (S/U)
-suunnittelijankin tulee tietää mitä antureita yms. tarvitaan jotta voidaan tehdä toimivia ehtolauseita 2 (S/U)
-omakotirakentamisessa on kuulemma ollut paljonkin, mm. LON-väylän kytkeminen IHC:n kanssa 3 (U)
-en tiedä onko ollut 5 (S)
-iv-säätö ja mittausten järkeistäminen vaikeaa, tai lämmitysjärjestelmät, maalämpöpumppu (vain hälytystieto saadaan) 6 (U)
-ehkä antureissa ollut jotain, aika vähän niissäkään 7 (S/U)
-sähkösuunnittelijan on vaikea tietää, kun ei ole lopussa mukana, ehkä ongelmat on lähinnä ohjelmoinnissa. Murtohälyttimen yhdistäminen. 8 (S/U)
-en ole huomannut KNX:n yhteydessä, ainakin saman valmistajan tuotteet sopivat yhteen 9 (S/U)

6) *Mitkä ovat yleisimmät ongelmat kotiautomaation asennuksessa?*
5 vastausta
-keskeneräisten asennusten käyttöönotto 1 (S/U)
-suunnittelijat ei osaa tehdä suunnitelmia, ei ole koulutusta 2 (S/U)
-ohjelmointipuoli, koska niitä tehdään niin vähän 3 (U)
-lukituksien kanssa on ollut vähän, kun oli eri valmistajan keskus ja painikkeet, led-indikointi lukituksessa, mutta sekin oli ohjelmoinnissa se ongelma 8 (S/U)
-menee pääsääntöisesti helposti 9 (S/U)

5. KÄYTTÄJÄ

1) *Tietävätkö kuluttajat kotiautomaatiojärjestelmistä? Entä uusimmista tuotteista?*
9 vastausta
-vain pieni osa tietää, suuri osa ei ole kuullut mitään 1 (S/U)
-tietää melkein enemmän kuin urakoitsijat, he pyörivät messuilla 2 (S/U)
-ei tiedä, se on suurin ongelma. Ihmisten pitää osata kysyä asiaa, järjestelmiä ei markkinoida 3 (U)
-on niitä valveutuneitakin, mutta yleensä joutuu selittämään mitä nämä järjestelmät tarkoittaa 4 (S)
-kyllä ne hakee tietoa, ehkä ne tietää jonkun järjestelmän 5 (S)
-aika vähän ne tietää, suunnittelijan kautta ne tulee 6 (U)

-nykyisin jos on valveutunut ihminen niin se tietää aika paljon mitä on markkinoilla. 7 (S/U)
-jotain ominaisuuksia tiedetään muttei kauheasti, osa on kuullut, ehkä 30% asiakkaista 8 (S/U)
-yli puolet tietää, mutta ovat sitä mieltä ettei automaatiota tarvita 9 (S/U)

2) *Tietääkö asiakas etukäteen millaisen kotiautomaatiojärjestelmän hän haluaa?*
3 vastausta
-asiakkaat yleensä tietävät mitä he haluavat 5 (S)
-tietää etukäteen jotain, mutta ei kaikkea pysty kuvittelemaan etukäteen, tieto lisääntyy matkan varrella 7 (S/U)
-pääsääntöisesti tietävät minkä järjestelmän haluavat ja suunnittelija auttaa valitsemaan sopivat ominaisuudet 9 (S/U)

3) *Tietääkö asiakas etukäteen mitä ominaisuuksia kotiautomaatiojärjestelmässä tulisi olla?*
3 vastausta
-on kyllä ollut kohteita jossa IHC:ta on käytetty todella huonosti, esim. parin huoneen valaistuksen ohjaukseen 3 (U)
-kyllä niitä käydään aika paljon läpi asiakkaan kanssa 8 (S/U)
-pääsääntöisesti asiakkaalla on tiedossa mitä ominaisuuksia hän haluaa 9 (S/U)

4) *Miksi asiakas haluaa käyttää kotiautomaatiota talossaan?*
-minuakin kiinnostaisi tietää, joku on sanonut että se on tulevaisuutta ja koti on ajanmukainen vielä tulevaisuudessakin 1 (S/U)
-helpottaakseen elämää, säästääkseen energiakuluja, asumisen helppous, pystyy hallinnoimaan koko taloa helposti 2 (S/U)
-ihmiset pitää mukavana valojen ohjausta kaukosäätimellä, sitten on pientä brassailua, aika moni tekee kotiteatterijärjestelmän ja moottoriverhot tai markiisit 3 (U)
-helpottaa ja antaa mukavuutta, kaikki saa yhdestä kohtaa tehtyä, energiansäästöä on kyselty (ei saada säästöä). pienempien talojen rakentajat eivät ole edes kiinnostuneita 4 (S)
-en oikein tiedä, se varmaan että kaikkea voi ohjata, mukavuustekijä, talon jälleenmyyntiarvo säilyy ja helpompi myydä, yleensä kuitenkin rakennetaan taloa itselle eikä ajatella myyntiä 5 (S)
-valaistuksen ohjaus on kysytyin, lämmityksen ohjaus, turvajärjestelmät, vesivuotohälytykset yms. 6 (U)
-minua sähköurakoitsijana kiehtoo se mahdollisuus, että kun ei olla itse paikalla niin koti hoitaa itsensä automaattisesti ja saadaan vaikka kännykällä tietoa hälytyksistä. 7 (S/U)
-Kaikki valot pois tai valaistustilanteet 8 (S/U)
-halutaan mukavuutta, viimeisintä teknologiaa (”teknofriikit”) tai ”parasta mitä on” 9 (S/U)

5) *Mitkä kotiautomaatiotoiminnot ovat tärkeimmät/olennaisimmat asiakkaalle?*
6 vastausta
-turvallisuusjärjestelmä 1 (S/U)
-kokonaisvaltainen järjestelmä, ohjattu valaistus, iv, lämmitys, siihen tulee kaikki samaan hintaan 2 (S/U)
-valaistuksen merkitys aletaan ymmärtää, tilatoimintoja ei tavallinen ihminen tiedä 3 (U)
-lämmityksen säätö ja valaistusohjaus 4 (S)

-valaistuksen ohjaus tärkein, epäilen, ettei tilatoimintoja käytetä paljoa kodeissa 5 (S)
-valaistus on tärkein ja kotona-poissa-toiminto 8 (S/U)

6) *Onko helppo löytää asiakkaan tarpeisiin sopiva järjestelmä?*
4 vastausta
-periaatteessa kyllä, mutta kun pitää huomioida kustannukset niin siihen se helppous loppuu 1 (S/U)
-ei tehdä oikeastaan muuta kuin KNX, IHC on hyvä järjestelmä mutta raskas suunnitella 2 (S/U)
-on helppo löytää komponentit EIB:llä 4 (S)
-KNX, sillä ei tarvitse kattaa koko taloa, jälkikäteen laajentaminen onnistuu langattomilla tai jos tehdään talo heikkovirtapainikkeilla. 8 (S/U)

7) *Kenen tulisi markkinoida kotiautomaatiojärjestelmistä asiakkaalle? Entä kuka mielestäsi tällä hetkellä tekee sen? Ehdotatteko itse kotiautomaatiojärjestelmää asiakkaalle, joka saattaisi olla kiinnostunut monipuolisemmasta talovarustelusta?*
9 vastausta
-laitevalmistajien pitää tehdä markkinointia, meillä suositellaan kaikille asiakkaille 1 (S/U)
-KNX:n pitäisi tehdä kuluttajille mainontaa, että tällainen järjestelmä on olemassa. Sitä ennen pitäisi kouluttaa suunnittelijat ja urakoitsijat jotta niitä osataan tehdä. Meille on muillakin aloilla "luotu tarpeet" esim. kännykät, että kyllä se onnistuisi kotiautomaatiossakin 2 (S/U)
-valaistussuunnittelija voisi tuoda esiin järjestelmiä, laitevalmistajien/-toimittajien pitäisi tehdä markkinointia 3 (U)
-en tiedä mistä asiakkaat alkaa taloja katselemaan, sinne pitäisi saada mainontaa 4 (S)
-laitevalmistajat ja suunnittelijat voi mainostaa 5 (S)
-laitevalmistajien pitäisi olla suunnittelijoihin päin yhteydessä. Urakointivaiheessa se on jo vähän myöhäistä, silloin suunnitelma pitää heittää roskiin ja aloittaa alusta 6 (U)
-rakentajille pitäisi markkinoida, ihmiset käyttää paljon puskaradioa jos he hakevat urakoitsijaa. Paljon käytetään nettiä, rautakaupat joissa rakentajat käy on aika suuressa roolissa ja vastaava mestari joka valvoo rakentamista. 7 (S/U)
-laitetoimittajien pitäisi markkinoida rakentajille. Minusta suunnittelijoilla on aika hyvin tiedossa, suunnittelijalle ei ole iso vaiva tehdä kumpi vaan, perinteinen tai automaatiojärjestelmä. Jos olisi demolaitteistoja niin niitä voisi esitellä asiakkaille. 8 (S/U)
-valmistajat ja maahantuojat, jos tarjoan suunnitelmia niin kerron aina myös automaatiojärjestelmistä, mutta en ala myymään. Aina ensimmäiseksi kysytään mitä maksaa, ei haluta edes tietää mitä sillä hinnalla saa. 9 (S/U)

6. *TULOKSET*

1) *Miten hyvin kotiautomaatiojärjestelmien toteutus on onnistunut? Mikä toimii parhaiten?*
9 vastausta
-lähes aina on jotain ongelmia, mitä olisi pitänyt voida välttää. Parhaiten onnistuu valaistuksen ohjaus 1 (S/U)
-aika vähän saadaan negatiivista palautetta, jos me tiedetään mitä asiakas haluaa, hän myös saa sellaisen järjestelmän 2 (S/U)

-Valaistus onnistuu parhaiten, pienet asiat esim. astianpesukoneen alla vuotoanturi, joka alkaa vilkuttaa keittiön valoja ja asiakas näkee että järjestelmä toimii, ne on ne yksityiskohdat ja toiminnot mitä on jouduttu miettimään. 3 (U)
-ei ole tullut palautetta, luulen että jos olisi ollut vikoja niin olisi tullut palautetta. 4 (S), 5 (S)
-ei ole kukaan valittanut. käydään tarvittaessa tekemässä käyttöönopastus pariin otteeseen, ja neuvotaan puhelimitse tai korjataan ensimmäisen vuoden ajan, meillä on urakkatakuu. 6 (U)
-ei ole vielä ollut automaatiokohteita 7 (S/U)
-ei ole kuulunut jälkeenpäin, että ei suunnittelija tiedä. Ne mitä on urakoitukin on onnistunut hyvin ja asiakas on ollut tyytyväinen 8 (S/U)
-ne mitä tehdään onnistuu hyvin ja ne missä suunnitelmat on tulleet muualta onnistuu hyvin ja huonosti, riippuen suunnitelmista. 9 (S/U)

2) *Millaisia ongelmia asiakkailla on ollut kotiautomaatiojärjestelmien asennuksen, käyttöönoton tai käytön yhteydessä?*
7 vastausta
-turvatekniikka on joissain määrin vaikeaselkoista ja herkkää väärille hälytyksille 1 (S/U)
-yleensä asennusteknisiä asioita, käyttöönotossa tulee joskus ongelma ettei asennukset ole valmiita kun pitäisi ladata/testata ohjelma, urakoitsija ei ole saanut kaikkea valmiiksi. Rakentamisessa helposti tulee viivästyksiä 2 (S/U)
-ei ole ollut, koska suurin osa käyttää perustoimintoja kuten valaistuksen ohjaus 3 (U)
-ei ole tarkempaa tietoa, luulen että lähinnä ohjelmointipuolella 5 (S)
-ei ole kauheasti ongelmia 6 (U)
-järjestelmä pitää tehdä niin helpoksi että sitä osaa kuka vain käyttää 7 (S/U)
-usein tehdään niin, että asukas asuu ensin päälle-pois ohjauksilla ja miettii rauhassa mitä toimintoja hän haluaa ja ne ohjelmoidaan jälkikäteen 8 (S/U)

3) *Miksi mielestäsi kotiautomaatio ei ole yleistynyt vuosien kuluessa?*
9 vastausta
-tähän mennessä ei ole ollut riittävän monipuolisia tuotteita ja komponentteja, vasta viime vuosina tilanne on alkanut parantua 1 (S/U)
-tarvitaan yleistä markkinointia, koulutuksen puute, suunnittelijoiden halukkuus, joku porkkana miksi haluaisivat tehdä näitä kun perinteisilläkin saa tehtyä, urakoitsijoiden koulutus, ensin pitää saada kuluttajat tietoisiksi ja ammattilaiset koulutettua. Ongelmana on ollut että on myyty tavaraa ”hulluna” ja sitten vasta huomattu ettei kukaan osaa suunnitella/asentaa/ohjelmoida niitä järjestelmiä ja kaikki kaatuu maahantuojan niskaan. Kokonaisvaltainen palvelu on tärkeintä, esim että järjestelmät myydään käyttöönotettuna, myydään tavara aina projekteina. 2 (S/U)
-urakoitsija voi lähinnä torpedoida idean, ollaan liian konservatiivisia. Järjestelmiä on myyty ihan liian vaikeana, erikoisena ja isona (esim IHC) vaikka ne palikat on ihan yksinkertaisia. Miksei Suomessa ole mainostettu TV:ssä? 3 (U)
-järjestelmät nostaa hintaa, siitä ei ole hyötyä jos ei oteta lämmitystä mukaan ja ohjataan vain paria valoa. 4 (S)
-hinta ja markkinoinnin puute 5 (S)
-rahastahan kaikki puhuu, sääli että rakentamiseen voidaan laittaa paljon rahaa mutta talotekniikkaan ei olla valmiita satsaamaan 6 (U)
-ei ole markkinoitu riittävästi. Tietämystä pitäisi lisätä vastaaville mestareille, sähköurakoitsijoille, talotehtaan myyjille jne. 7 (S/U)
-markkinointi puuttuu, miksei vaikka televisiossa toimittajien yhteinen mainonta? 8 (S/U)

-sähköpuolella näköjään riittää että sähköä tulee ja valot syttyy ja sammuu. Hinta on ollut esteenä, perinteisellä sähköistyksellä saadaan vastaavia toimintoja. Ihmisten tietämys on vajaavaista, ne ei luota järjestelmään. Pelkällä mukavuudella on paha myydä mitään, ei se riitä. Urakoitsijalle ei ole hyötyä opetella näitä paitsi oma kehitys, mielenkiinto ja ollaan tulevaisuudessa paalupaikalla. 9 (S/U)

4) *Kuinka suuri osa asiakkaistanne asennuttaa kotiautomaatiojärjestelmiä pienrakentamisessa? Lukuina tai prosentteina: Omakotitalot, rivitalot, mökit?*
4 vastausta
-noin 70%, omakotitaloja ja ok-talon kokoisia kakkosasuntoja 1 (S/U)
-99% 2 (S/U)
-ei vielä kukaan 7 (S/U)
-15%, viime vuosi oli poikkeuksellinen kun oli 2 kohdetta 9 (S/U)

5) *Miten kotiautomaatiota voitaisiin tehdä tunnetummaksi?*
7 vastausta
-iso TV-kampanja, remonttireiskassa? Ainakin langattomien kytkimien myynti pomppasi kun Reiska esitteli niitä TV:ssä 1 (S/U)
-yleistä markkinointia lisää 2 (S/U)
-ihmiset katsovat paljon Innoa ja muita sisustusohjelmia, ei tarvitsisi näyttää yhtä järjestelmää sillä niillä voi yleensä tehdä samat asiat, ei tarvitse mennä yksityiskohtiin. Kysyntä pitäisi syntyä ensin jotta tuotteita menisi kaupaksi. Tuotteita esitellään lähinnä vain ammattilaismessuilla, mutta kuluttajien pitäisi ensin saada tietoa. 3 (U)
-ehkä TV:ssä, vaikea sanoa mistä maallikot saavat tietoa 5 (S)
-näitä sovellutuksia pitää selventää paremmin kuluttajille, kyllä se suunnittelija on avainasemassa pientalopuolella 6 (U)
-onhan niitä TV-ohjelmia, kuningaskuluttajaa ja remontti-Reiskaa. Järjestelmiä on mainostettu vähän, pidetään kynttilää vakan alla. 7 (S/U)
-Ehkä TV:ssä joka kodin asuntomarkkinat ja rakennusohjelmat voisi olla vaihtoehto. Nettisivut pitäisi olla selkeät ja suomenkieliset. Kannattaa olla yleistä tietoa, tuotteet on niin teknisiä. Järjestelmiä mainostetaan vain ammattilaismessuilla, asuntomessuilla on lähinnä kokonaisjärjestelmiä, siellä pitäisi olla isot plakaatit järjestelmistä mutta kuluttajat haluaa vain teitää hinnan. Valaistuksen säädön suosio johtuu varmaan siitä, että sitä on eniten tuotu esiin sisustusohjelmissa yms. ja sitä kautta saatu uusia ideoita. Se on konkreettisin alue automaatiosta ja helpoin ymmärtää. 9 (S/U)

6) *Millaisia muutoksia näet rakentamisessa tulevaisuudessa?*
9 vastausta
-volyymi näyttää olevan laskemaan päin, toivon sen parantavan laatua 1 (S/U)
-etäohjaus, webbiliittymät kehittyy, myyntitilanteessa viiden vuoden kuluttua, kun automaatiojärjestelmät alkaa olla enemmän tunnettuja, herää kysymys että onko talossa tällainen järjestelmä ja jos ei niin miksi? 2 (S/U)
-en usko että mikään muuttuu, voitaisiin valvoa ja pienentää energiankulutusta näillä järjestelmillä mutta sitä pitäisi tuoda esiin paremmin 3 (U)
-led-valaisimet on tulossa 4 (S)
-en tiedä onko suurta muutosta, uskon että väylätekniikka tulee yleistymään omakotitaloissa 5 (S)
-automaation myyntimäärät on vähän kasvanut, mutta asiakkaalle automaatio on usein liian monimutkaista ymmärtää 6 (U)
-siihen menee aikaa että urakoitsijat tiedostaa mitä on markkinoilla, tieto menee vain niille jotka osallistuu messuille ja koulutuksiin yms. 7 (S/U)

-varmaan automaatio tulee lisääntymään, ”karvalakkimalli”-sähköistykset tulevat vähenemään. Ulkonäköasiat kehittyy ehkä eniten. 8 (S/U)
-Ehkä KNX on se järjestelmä, joka tulee yleistymään, pysytään varmaan samoissa myyntimäärissä ellei tule jotain potkua laitevalmistajilta tai maahantuojilta. 9 (S/U)

APPENDIX 5: QUESTIONNAIRE RESULTS

ID	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**AVE**	**MED**
	S	S/U	S/U	U	S/U	S/U	S/U	S/U	S/U	S/U		
Minulla on työkokemusta	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**AVE**	**MED**
5=yli 10 vuotta 4=4-10 vuotta 3=2-4 vuotta 2=alle 2 vuotta 1=ei yhtään												
Perinteiset sähköjärjestelmät suunnittelu	4	5	5	1	5	5	2	5	4	4	4	4,5
Perinteiset sähköjärjestelmät Urakointi	1	4	5	5	5	5	3	5	4	5	4,2	5
Perinteiset sähköjärjestelmät asennukset	1	5	5	5	5	5	5	5	4	5	4,5	5
Peruskotiautomaatiojärjestelmät (ECO-600, Ensto Smart) suunnittelu	1	3	1	1	5	4	1	3	1	3	2,3	2
Peruskotiautomaatiojärjestelmät (ECO-600, Ensto Smart) Urakointi	1	3	4	4	5	4	1	3	1	5	3,1	3,5
Peruskotiautomaatiojärjestelmät (ECO-600, Ensto Smart) asennukset	1	3	4	4	5	4	1	3	1	5	3,1	3,5
KNX/EIB/LON yms. väyläpohjaiset kotiautomaatiojärjestelmät suunnittelu	3	4	2	1	2	4	2	1	4	3	2,6	2,5
KNX/EIB/LON yms. väyläpohjaiset kotiautomaatiojärjestelmät urakointi	1	4	2	4	2	4	2	1	3	3	2,6	2,5
KNX/EIB/LON yms. väyläpohjaiset kotiautomaatiojärjestelmät asennukset	1	4	2	4	2	4	2	1	3	3	2,6	2,5
”Älytalo” –ratkaisut suunnittelu	2	1	1	1	5	1	1	4	1	3	2	1
”Älytalo” –ratkaisut urakointi	1	1	5	4	5	1	1	4	1	3	2,6	2
”Älytalo” –ratkaisut asennukset	1	1	5	4	5	1	1	4	1	3	2,6	2
Langattomat järjestelmät suunnittelu	2	2	1	1	2	1	1	4	3	3	2	2
Langattomat järjestelmät urakointi	1	2	4	3	2	1	2	4	2	3	2,4	2
Langattomat järjestelmät asennukset	1	2	4	3	2	1	2	4	2	3	2,4	2
1.Kotiautomaatio (KA) pientalorakentamisessa	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**AVE**	**MED**
5=täysin samaa mieltä 4=jokseenkin samaa mieltä 3=en osaa sanoa 2=jokseenkin eri mieltä 1=täysin eri mieltä												
Pientalorakentamisessa tulisi mielestäni hyödyntää enemmän kotiautomaatiota	4	5	3	5	4	4	4	5	4	5	4,3	4
Pientaloissa kotiautomaation hyödyt jäävät vähäisiksi niiden hintaan verrattuna	3	2	5	2	4	4	4	2	4	4	3,4	4
Käytän vain tietyn valmistajan KA-järjestelmiä. (voit mainita valmistajan kohdassa lisätietoja)	2	4	2	2	2	5	1	2	2	4	2,6	2
KNX/EIB on suosituin kotiautomaatiojärjestelmä muutaman vuoden kuluttua	4	5	4	3	3	2	5	2	5	5	3,8	4

Pientalojen KA-järjestelmät kehittyvät lähivuosina kohti ”älytaloa”	3	4	3	4	4	3	4	5	5	5	4	4
Pientalojen KA-järjestelmät pysyvät yksinkertaisina ja releohjaukset riittävät	2	2	2	2	2	4	3	2	1	3	2,3	2
Langattomat KA-järjestelmät ovat kokonaiskustannuksiltaan edullisempia kuin kiinteät	4	0	2	2	4	3	3	4	2	3	2,7	3
KNX/EIB-väyläratkaisut ovat liian kalliita pientalorakentamiseen	4	2	4	2	4	4	4	4	1	4	3,3	4
KNX/EIB-väyläratkaisut ovat liian monimutkaisia pientalorakentamiseen	2	1	4	2	2	3	2	4	1	2	2,3	2
KNX/EIB-ratkaisut soveltuvat pientaloihin paremmin kuin yksinkertaiset KA-järjestelmät	3	3	2	4	2	3	4	2	4	4	3,1	3
KA-järjestelmien käyttöikä on yli 10 vuotta	4	3	3	5	4	4	5	4	5	5	4,2	4
2.Pientalon rakennusurakka	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**AVE**	**MED**
5=täysin samaa mieltä 4=jokseenkin samaa mieltä 3=en osaa sanoa 2=jokseenkin eri mieltä 1=täysin eri mieltä												
Pientalojen nykytekniikka on hyvin samankaltaista kuin 80-luvulla	3	4	4	2	2	4	4	2	1	2	2,8	2,5
Tyypillisesti asiakas teettää KA-järjestelmän sähkösuunnitelmat ennen urakkatarjousta	3	4	4	5	4	2	4	4	1	2	3,3	4
KA-järjestelmän suunnittelu ja toteutus pientaloissa tulee sisällyttää sähköurakkaan	2	1	2	5	1	5	4	4	1	3	2,8	2,5
KA-järjestelmän suunnittelu ja toteutus pientaloissa tulee pitää erillisurakkana	3	1	4	1	2	2	2	1	1	3	2	2
KA-järjestelmät on yleensä esitetty riittävän yksityiskohtaisesti sähkösuunnitelmissa	3	1	1	2	1	5	2	2	4	2	2,3	2
KA-järjestelmän sisältävän sähkösuunnitelman perusteella on yleensä helppo tehdä pitävä urakkatarjous	3	1	1	4	2	5	2	4	3	2	2,7	2,5
KA-järjestelmän sisällyttäminen sähköurakkaan aiheuttaa usein yllättäviä lisäkustannuksia rakennusvaiheessa	3	5	5	2	2	5	2	2	1	4	3,1	2,5
KA-järjestelmän sisällyttäminen sähköurakkaan vaatii suuremman katteen urakkahintaan kuin muut sähköjärjestelmät, jotta yllättäviä lisäkuluja voidaan ennakoida etukäteen	3	5	5	2	2	5	2	2	1	4	3,1	2,5
Kaikkien pientalo-sähköurakoitsijoiden tulisi tehdä myös KA-urakointia	3	2	1	5	2	2	2	2	1	2	2,2	2
Vain sertifioitujen/lisensoitujen sähköurakoitsijoiden tulisi tehdä myös KA-urakointia	3	5	3	2	4	3	4	4	1	2	3,1	3

3.Kotiautomaatiojärjestelmän asennus	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**AVE**	**MED**
5=täysin samaa mieltä 4=jokseenkin samaa mieltä 3=en osaa sanoa 2=jokseenkin eri mieltä 1=täysin eri mieltä												
KA-järjestelmän asennus vaatii erityisosaamista jota ei löydy joka sähköasentajalta	3	4	5	2	4	5	4	2	2	5	3,6	4
On helppo löytää asentajia, jotka osaavat tehdä KA-järjestelmäasennuksia	3	4	1	2	2	1	1	2	3	4	2,3	2
KA-järjestelmien asennusta ei opi koulussa vaan työssä tekemällä	3	4	5	4	2	5	4	2	4	4	3,7	4
KA-järjestelmien asennuksesta tarvittaisiin lisäkoulutusta	3	4	5	4	4	4	5	4	3	4	4	4
KA-järjestelmien asennuksesta tarvittaisiin selkeämpiä ohjeita laitevalmistajilta/maahantuojilta	3	5	5	4	4	5	4	4	4	2	4	4
KA-järjestelmien asennusta vaikeuttavat yhteensopivuusongelmat	3	2	5	2	3	3	4	2	4	2	3	3
Eri sähköjärjestelmien yhteensovittaminen KA-järjestelmällä on vaikeaa (esim. lämmitys, ilmastointi, valaistus, äänentoisto, viihde-elektroniikka, tietotekniikka)	3	2	5	2	5	3	2	2	2	2	2,8	2
KA-järjestelmän käyttöönottoon liittyvä ohjelmointi ei ole vaikeaa	3	4	1	4	2	3	4	4	3	2	3	3
KA-järjestelmän ohjelmointia varten tarvitaan konsultti tai muu ulkopuolinen asiantuntija	3	4	5	2	4	2	2	2	4	4	3,2	3,5
Käyttämissäni KA-järjestelmissä ei tarvita ohjelmointia	3	1	1	2	1	2	1	2	1	1	1,5	1
KA-järjestelmää on helppo päivittää tulevien tarpeiden mukaan	3	5	1	4	4	3	4	4	5	5	3,8	4

4.Käyttäjät	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**AVE**	**MED**
5=täysin samaa mieltä 4=jokseenkin samaa mieltä 3=en osaa sanoa 2=jokseenkin eri mieltä 1=täysin eri mieltä												
Yksityisasiakkaat osaavat kysellä KA-järjestelmistä jo tilausvaiheessa	2	4	2	4	4	2	2	2	4	4	3	3
On helppo löytää yksityisasiakkaan tarpeisiin sopiva KA-järjestelmä	4	4	2	4	4	2	2	4	5	2	3,3	4
Yksityisasiakkaan on vaikea selvittää, millaisen KA-järjestelmän hän haluaa	4	4	5	4	5	4	4	2	5	5	4,2	4
KA-järjestelmän suunnittelu perustuu asiakkaan tarpeisiin	5	4	4	4	4	4	5	5	5	4	4,4	4
Yksityisasiakas voi itse valita KA-järjestelmän valmistajan ja laitteiston	4	2	3	2	2	4	5	5	4	4	3,5	4
Suosittelen yleensä asiakkaalle tiettyä KA-järjestelmää, joka sopii käyttötarkoitukseen	4	5	4	2	4	5	5	4	5	5	4,3	4,5

Suosittelen yksityisasiakkaalle yleensä yksinkertaisinta KA-järjestelmää	2	2	4	2	1	3	4	2	2	2	2,4	2
Suosittelen yksityisasiakkaalle yleensä kattavinta KA-järjestelmää	2	4	3	4	1	5	2	4	4	4	3,3	4
Suosittelen yksityisasiakasta käyttämään perinteistä sähköistystä	2	1	3	1	2	2	2	2	2	2	1,9	2
Asennettu KA-järjestelmä on lähes aina toiminut asiakkaan haluamalla tavalla	4	5	3	4	2	5	4	5	5	5	4,2	4,5
5.Tulokset	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**AVE**	**MED**
5=täysin samaa mieltä 4=jokseenkin samaa mieltä 3=en osaa sanoa 2=jokseenkin eri mieltä 1=täysin eri mieltä												
KA-järjestelmät tulevat yleistymään lähivuosina selvästi	4	5	2	4	4	3	4	5	5	5	4,1	4
KA-järjestelmän asennus on sujunut ongelmitta	3	4	1	4	4	4	4	5	4	5	3,8	4
KA-järjestelmissä on usein ilmennyt vikoja/ongelmia käyttöönoton jälkeen	3	2	5	2	2	3	2	1	2	2	2,4	2
KA-järjestelmät vaativat paljon huolto- ja ylläpitotoimia asennuksen jälkeen	3	1	5	2	2	3	2	1	1	1	2,1	2
KA-järjestelmien käytettävyyttä tulisi parantaa jotta ne yleistyisivät	4	2	5	4	4	4	4	4	1	2	3,4	4
KA-järjestelmien yleistyminen on kiinni tuotteiden markkinoinnista kuluttajille	4	4	2	4	5	3	5	5	5	4	4,1	4
KA-järjestelmien yleistyminen on kiinni urakoitsijoiden kiinnostuksesta markkinoida niitä asiakkailleen	3	4	3	2	5	5	4	5	4	4	3,9	4
Urakoitsijat eivät vaikuta KA-järjestelmien yleistymiseen	3	2	3	2	1	2	1	1	1	2	1,8	2
KA-järjestelmällä voidaan aikaansaada selviä säästöjä asumiskustannuksiin	4	4	2	5	2	2	4	5	2	2	3,2	3
KA-järjestelmällä voidaan aikaansaada selviä säästöjä energiankulutukseen	4	5	2	5	2	2	4	5	2	5	3,6	4
KA-järjestelmä parantaa pientalon myyntiarvoa	4	5	2	5	4	4	5	5	4	4	4,2	4
KA-järjestelmän tekniikka vanhenee liian nopeasti	2	1	5	2	2	3	2	2	2	4	2,5	2

APPENDIX 6: ADDITIONAL PHONE CONVERSATION RESULTS

Puhelu 1:

Ongelmia:

-laitteet on niin kalliita

-hinnoista tingitään, etenkin nuoret parit, varttuneemmat kiinnostuneempia

-asiakkaalla pankkilainoitus, maksuvalmius

-"hienostelu maksaa"

-"Hiace-miehet sählää", 1-2 henkilön yritykset koska muille kotirakentaminen ei ole kannattavaa toimintaa

-Sähkömies saa viimeisenä rahansa jos ei maksuvalmiutta -> ei innosta tekemään

-Keskukselle on oltava muu laitteisto, ohjauskeskuksia ym, keskuksen hinta nousee

-järjestelmät on ylimitoitettuja

-ei kunnon sähkösuunnittelua, jolloin urakkahinta ei päde:

--työmaavaiheessa muutokset on kalliita

--asukkaan kanssa tulee riitaa muutoksista

--vastuukysymykset ongelmallisia, urakoitsijat eivät halua suunnitella

-Suurin ongelma on riitautuminen asiakkaan kanssa ja joudutaan kuluttajaviraston kanssa ongelmiin.

-Esim. huoltotyössä minimihinta on 1h, tulee valituksia kun ollaan 25min töissä ja pitää maksaa 1h.

Niin paljoa ei saa kuin menettää.

-Tulossa on langattomat järjestelmät

Puhelu 2:

-Viime vuoteen ei olla asennettu automaatiota

-ei mitään järkeä esim. itseoppivissa järjestelmissä valojen sytyttäminen joka yö kun kerran kävi wc:ssä yöllä… Ei järkevää käyttöä kotona kun järjestelmät on niin kalliita, tai vaikka olisi puoli-ilmaisiakaan…

-langattomissa katkaisimissa tulee pariston vaihto eteen mikä ei ole järkevää, sähköjohdot kestää ainakin 20 vuotta.

-järjestelmät eivät ole niin hienoja oikeasti kuin mielikuvituksessa

-langattomat kytkimet ei vaadi sähköalan ammattilaista tekemään, voi tehdä itse tai joku timpuri.

-sähköalan tuotto tulee pysyvistä asennuksista, johdot tms. Nämä langattomat vaikuttaa väliaikaisratkaisuilta (pattereiden vuoksi). Jos ei tarvitsisi ladata niin se olisi ihan eri juttu.

-"Pelle Pelottomat voi haluta sellaisia"

-Lämmitys ja ilmanvaihto on ok, sieltä saadaan energiansäästöä yms. Todellista hyötyä. Myös hälytysjärjestelmät on kysyttyjä.

Puhelu 3:

-tehdään lähinnä rakennusyritysten kautta kerrostaloja

-ei mahdollista tehdä pieniä kohteita koska ovat niin kausiluonteisia (kesällä kaivetaan monttu, loka-joulukuussa tarvitaan sähköasentajaa)

-lisäksi isossa yrityksessä (meillä n. 900 kerrostalokohdetta) työmaita tulisi lukematon määrä eikä niiden perässä pysyisi

-isolla liikevaihdolla olevat yritykset eivät tee omakotitaloja vaan vain pienet yritykset (n.5 sähköasentajaa)

Puhelu 4:

-jos opettelee/investoi niin järjestelmät ehtii jo muuttua ettei se oikein kannata.

-en suosittele asiakkaille

-eri toimittajilla samankaltaisia tuotteita, mikä niistä nyt sitten olisi parempi?

-järjestelmät sopii jos tykkää kikkailusta, haluaa jotain erikoista ja jos on fyrkkaa

-normi-ihmiset ei osaa käyttää automaatiojärjestelmää enää vuoden kuluttua

-liian hieno systeemi

-en halua antaa mielipiteitä julkisesti (haastattelu)

Puhelu 5:

-ei olla tehty automaatiota

-jos tulee toimeksianto niin kyllä selvitään

-tehdään lähinnä huoltofirmojen kautta töitä, remontteja, korjauksia, saneerauksia yms.

Puhelu 6: (vastasi myös kyselyyn)

-en usko että hirveästi automaatiota käytetään

-lämpöpumppuja asennetaan

-IHC voidaan asentaa jos on sähkökuvissa (ilmeisesti oli kokemusta tästä)

-mitä edes tarkoitetaan kotiautomaatiolla?

APPENDIX 7: PARTICIPANT LISTING

Listing of participants who approved their information to be shown.

Device Manufacturers:

	Ensto Oy Matti Rae, Kimmo Rautiainen www.ensto.fi
	Schneider Electric Finland Oy Yki Kaisalo www.schneider-electric.fi
	Berker / DJS Automation Oy Niko Nissinen www.djsautomation.fi
	Elko Oy Kalevi Härkönen www.elko.fi

Electrical Contractors & Designers:

	Hendell Oy Ari Miettinen www.hendell.fi
	Hyvinkään Sähkö Oy Aki Junnila www.hyvinkaansahko.fi

	Insinööritoimisto Techniplan Oy Heikki Grundström www.techniplan.fi
	Laaksolahden Sähkö Oy Tommi Helander www.laaksolahdensahko.fi
	Saimatic Oy Vesa Saikko www.saimatic.fi
	Selega System Oy Lasse Honkala www.selega.com
	Suunnittelutoimisto Sähkö-Sirkiä Oy Matti Sirkiä www.sahkosirkia.fi
	Sähkösuunnittelu Klawers Oy Juha Jaatinen www.klawers.fi
	Top-Unit Oy Birger Lindström www.top-unit.fi

	Vaasan Sähköpalvelu Oskar Järnefelt www.vaasansahkopalvelu.fi
	Veikkolan Sähköpalvelu Oy Jarmo Viertokangas www.veikkolansahkopalvelu.fi
	Wiser Electrics Oy Raine Virkki www.wiser-electrics.fi